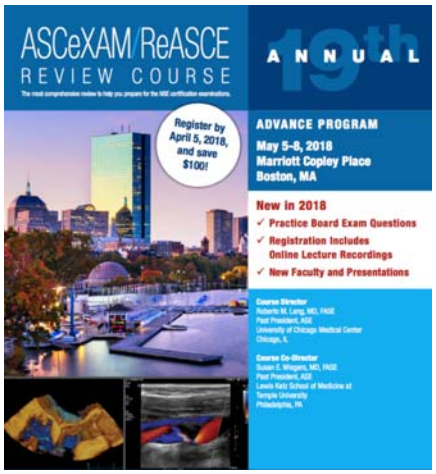
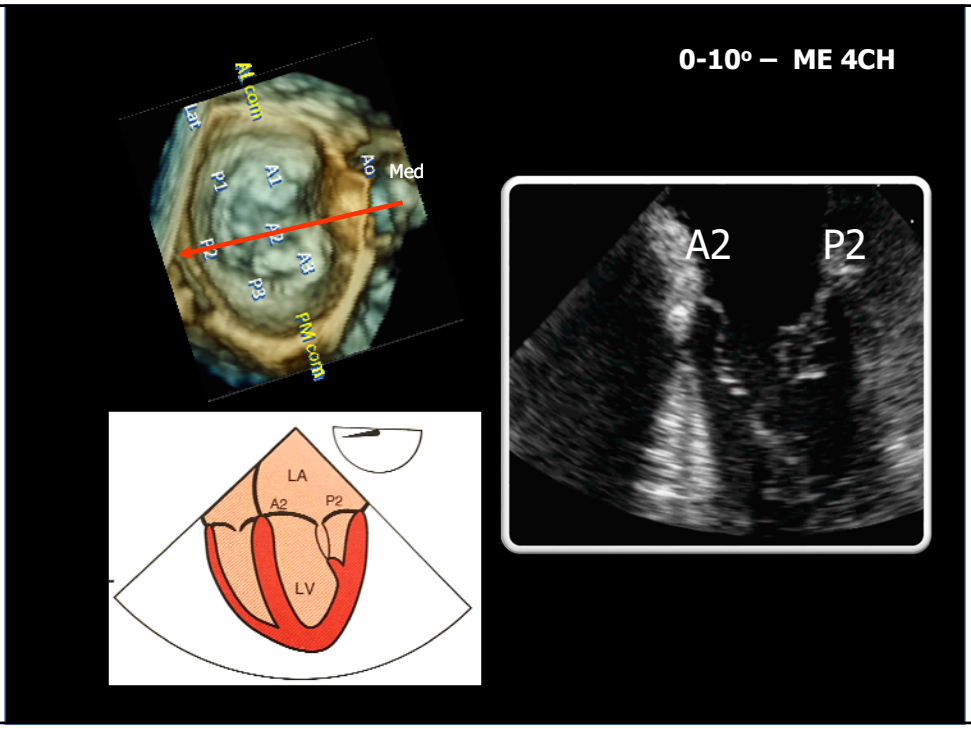
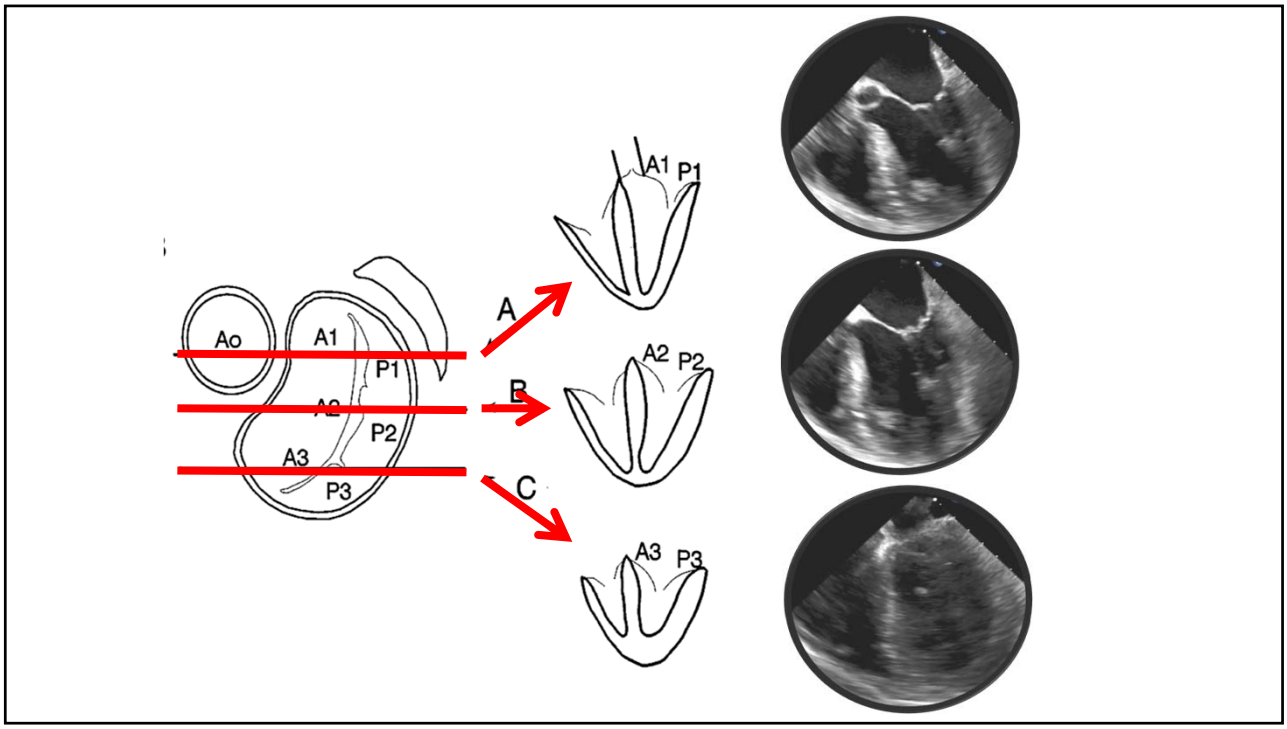


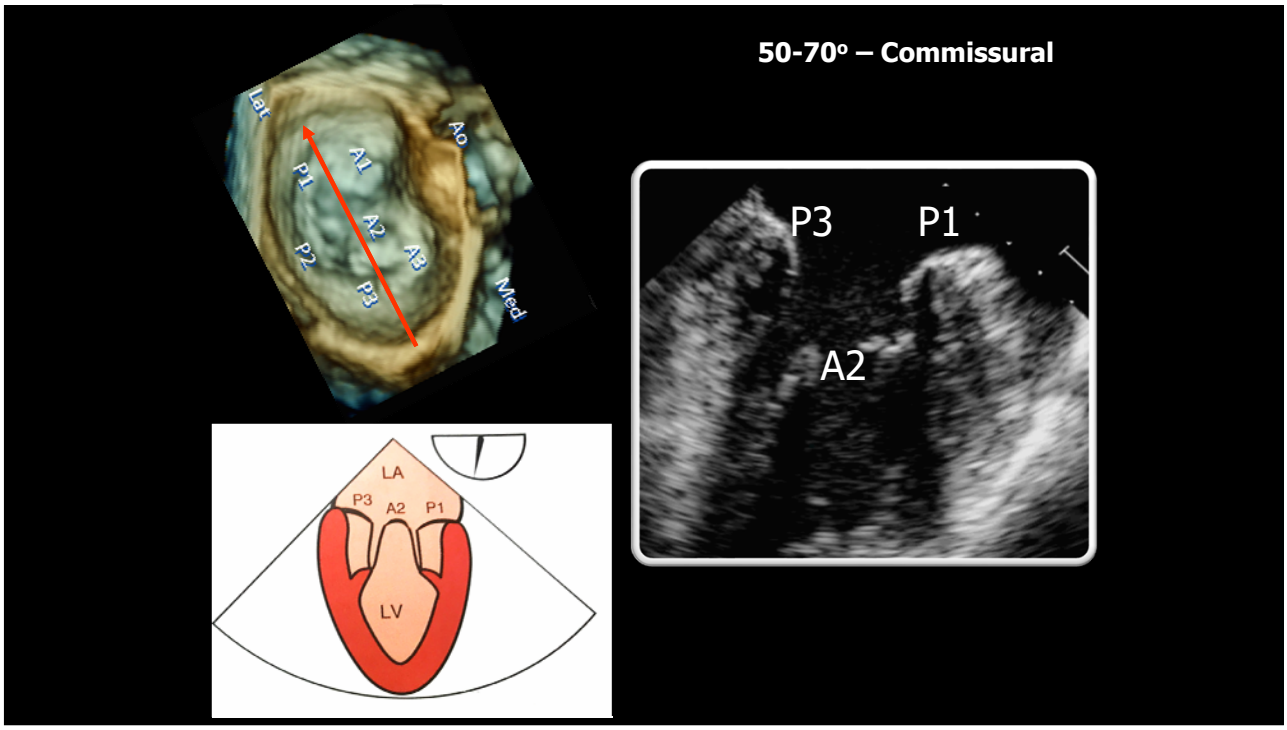
THE UNIVERSITY OF CHICAGO
CARDIAC IMAGING CENTER

Degenerative and Functional Mitral Valve Disease

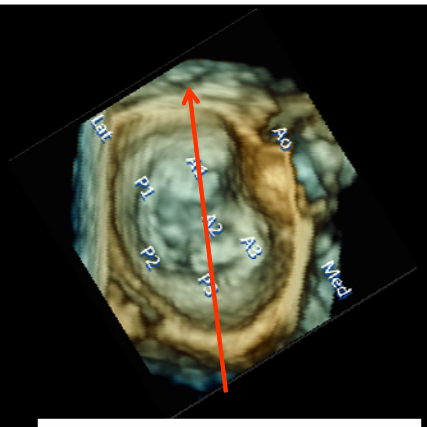
@RobertoMLang

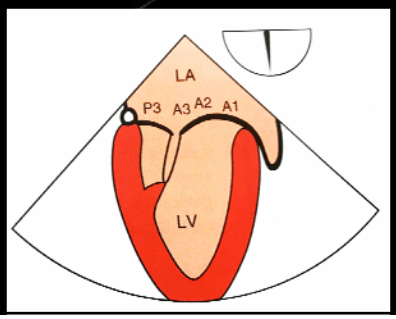


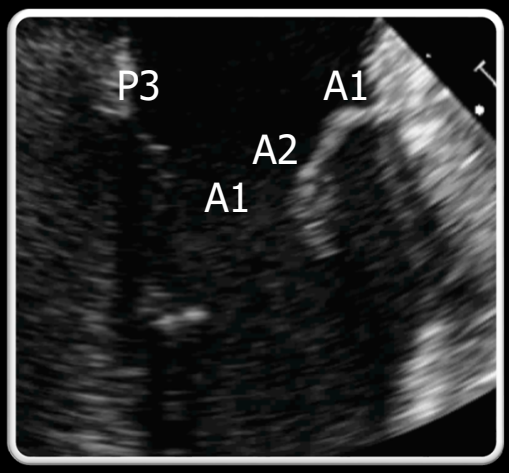

Ao
A1
P1
A2
P2
A3
P3
A
B
C
A1 P1
A2 P2
A3 P3


50-70° – Commissural
Lat
Ao
A1
P1
A2
P2
A3
P3
Med
LA
P3
A2
P1
LV
P3
P1
A2

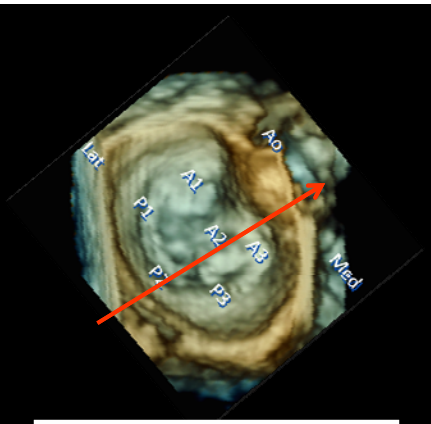
80-100° – ME 2CH

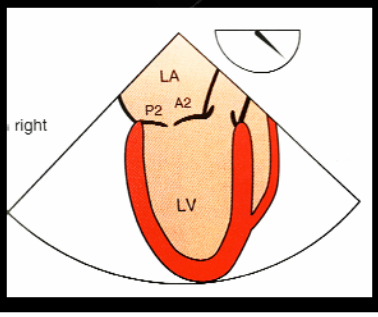


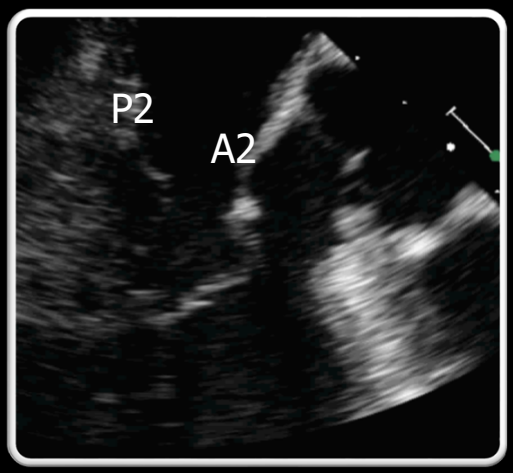


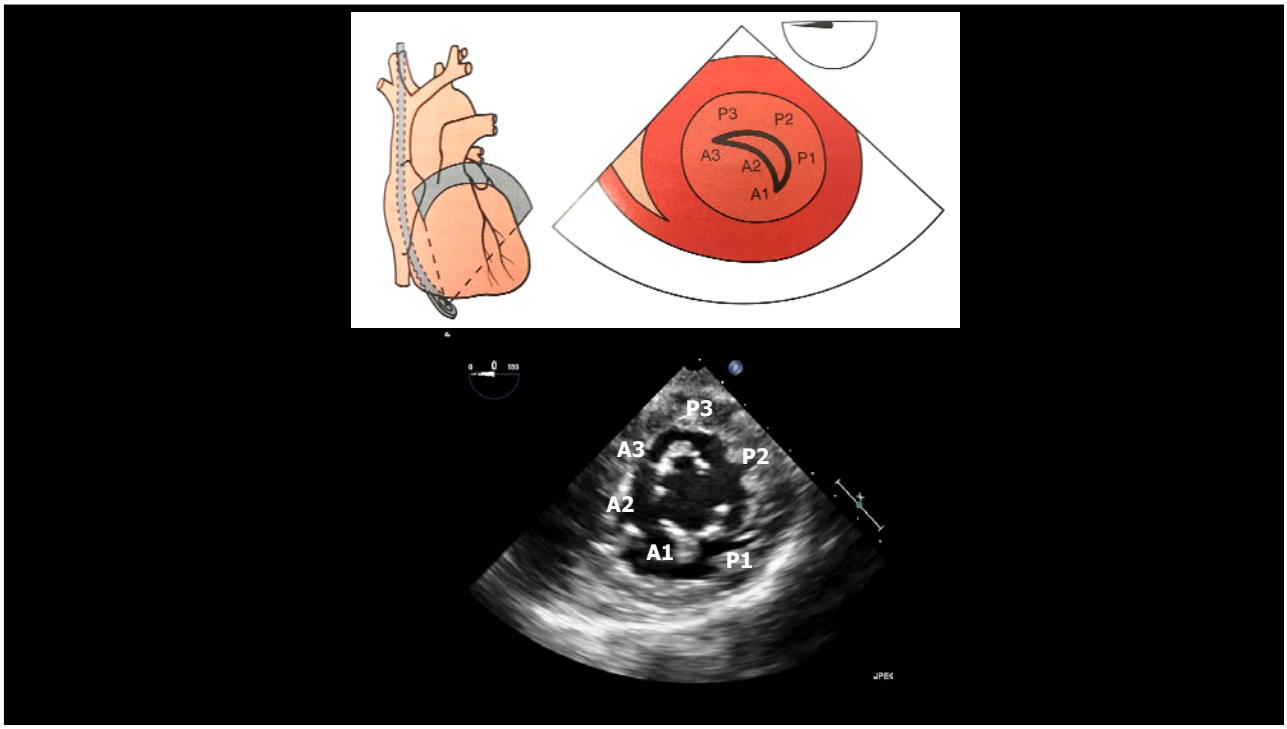


125-135° - ME Long axis

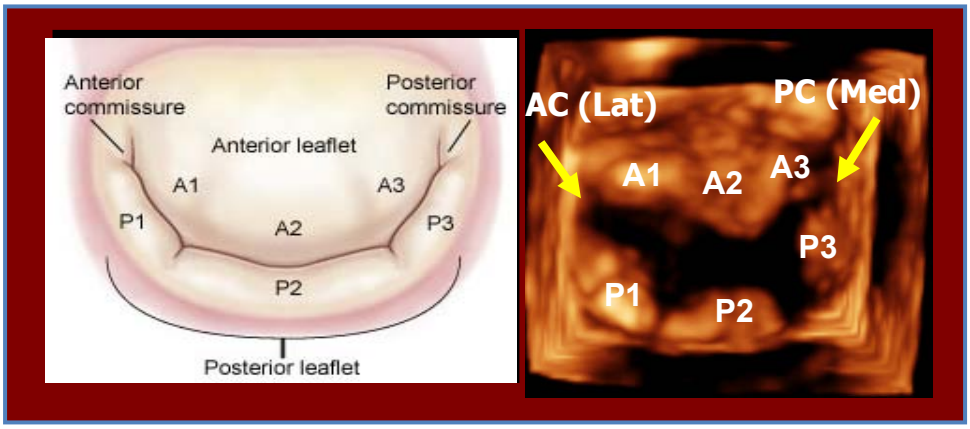




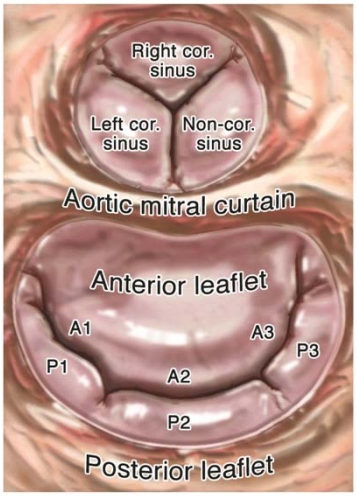


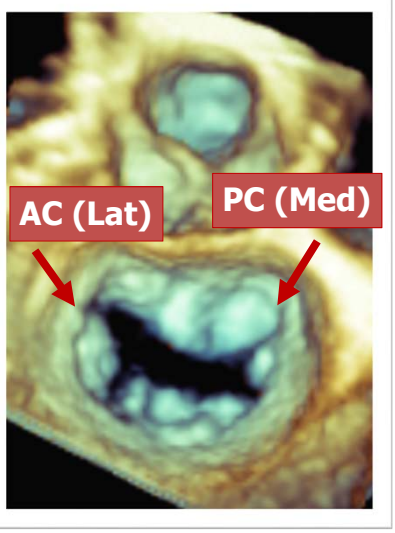

P3
P2
A3
A2
P1
A1
P3
A3
P2
A2
A1
P1

MV: 3D


Anterior commissure
Posterior commissure
Anterior leaflet
A1
A3
P1
A2
P3
P2
Posterior leaflet
AC (Lat)
PC (Med)
A1
A2
A3
P3
P1
P2

Surgeon's View of the MV





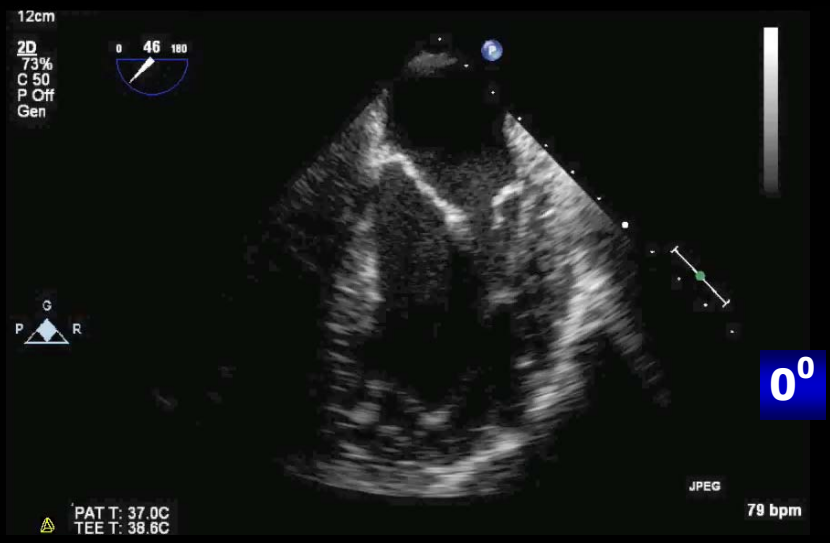
Lang RM, Tsang W, Weinert L, Mor-Avi V, Chandra S. J Am Coll Cardiol 2011 November 1;5 8(19):1933-1944.

Identify the culprit scallop

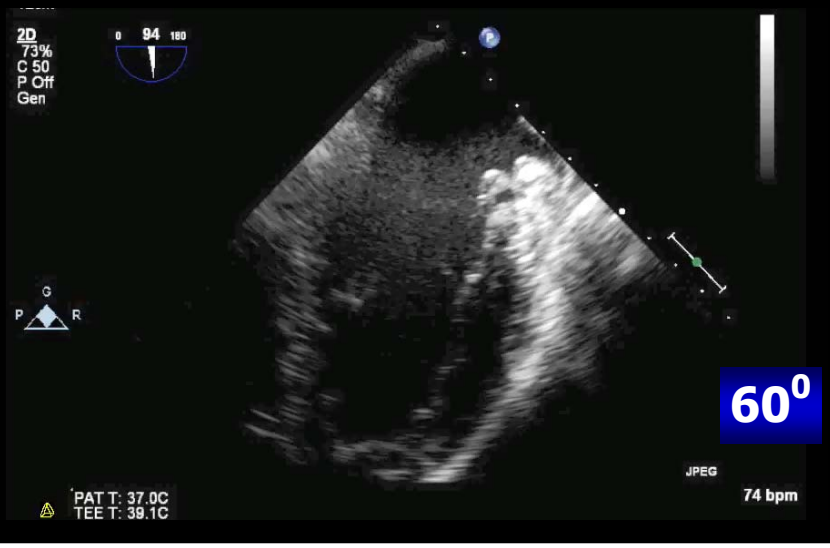
A4C: Anterior vs. Posterior

Bi Commissural: 3 vs. 2 vs. 1

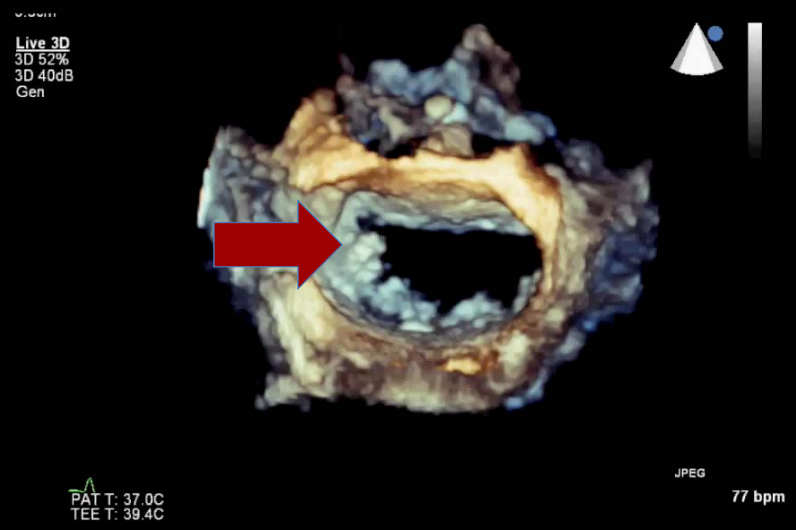
Case#1: Identify the prolapsing scallop



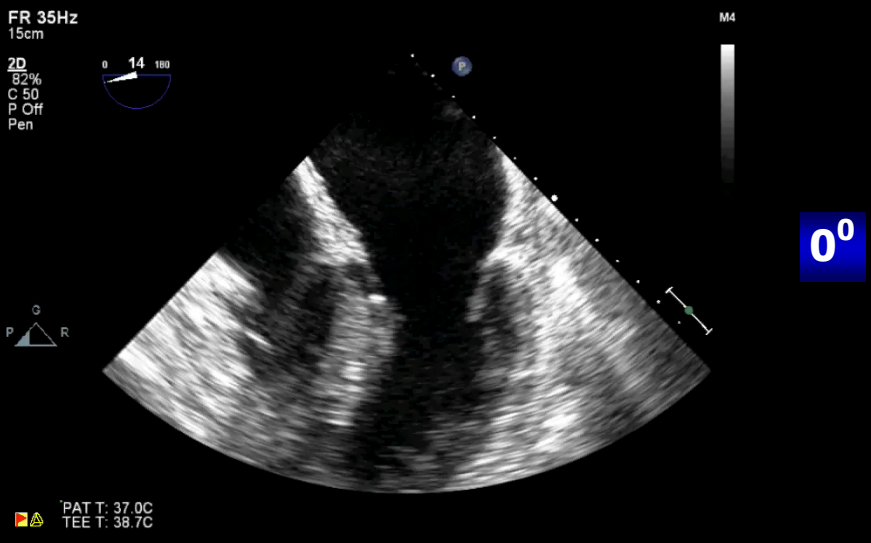
Case# 1: Identify the prolapsing scallop



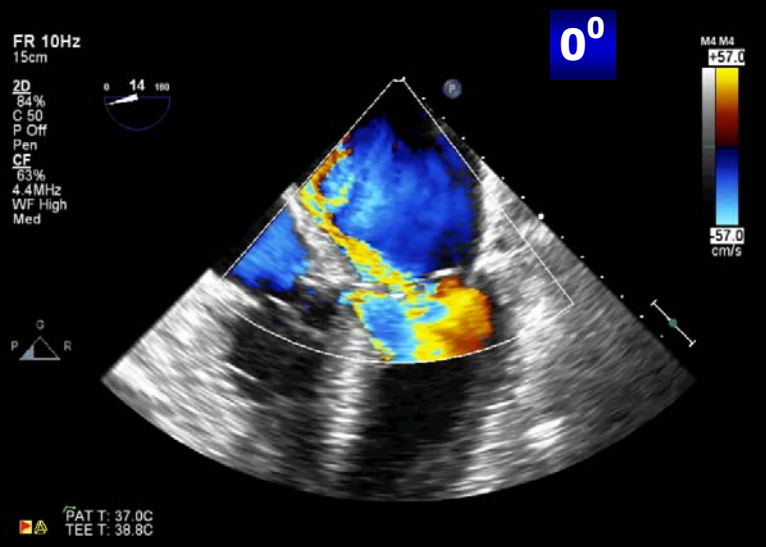
Case# 1: Identify the prolapsing scallop (P1)



Case# 2: Identify the prolapsing scallop



Case# 2: Identify the prolapsing scallop

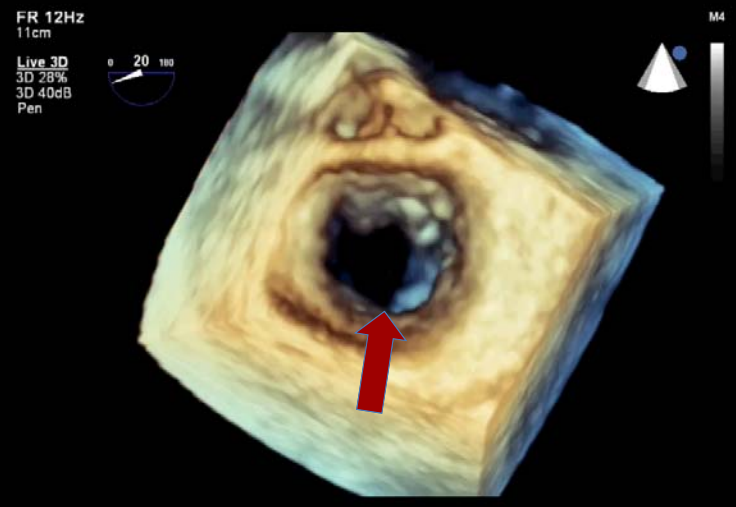


0^0

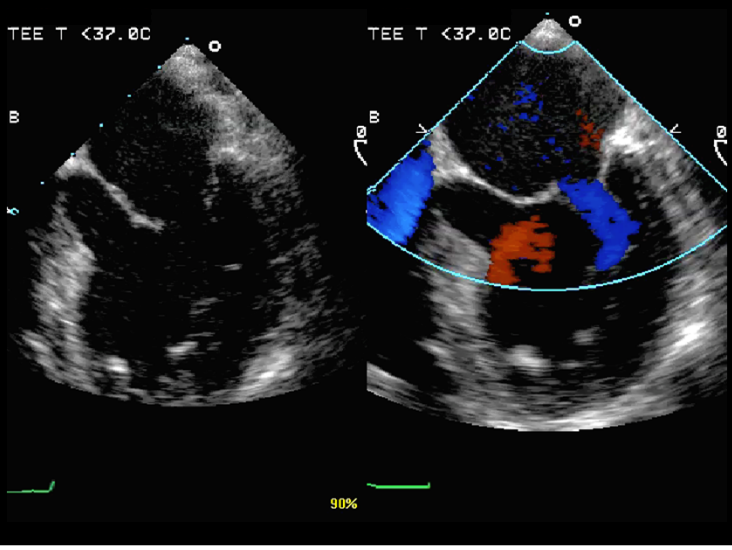
Case# 2: Identify the prolapsing scallop

60^0

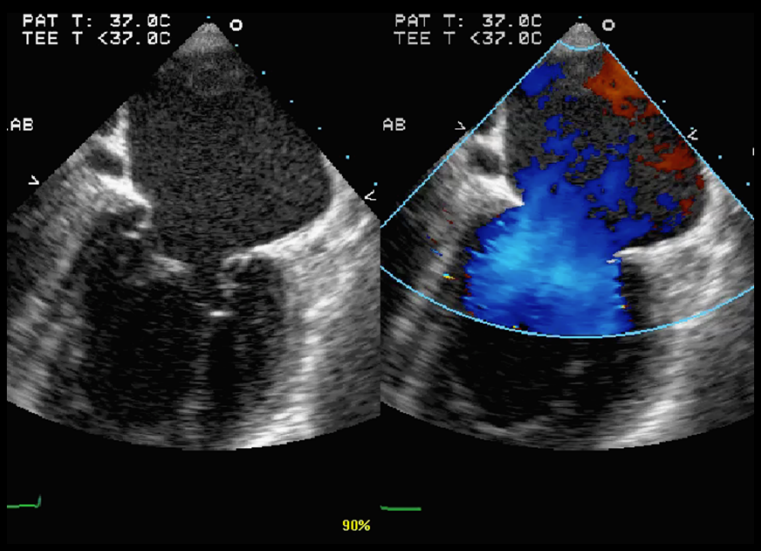
Case# 2: Identify the prolapsing scallop



Case# 3: Identify the prolapsing scallop

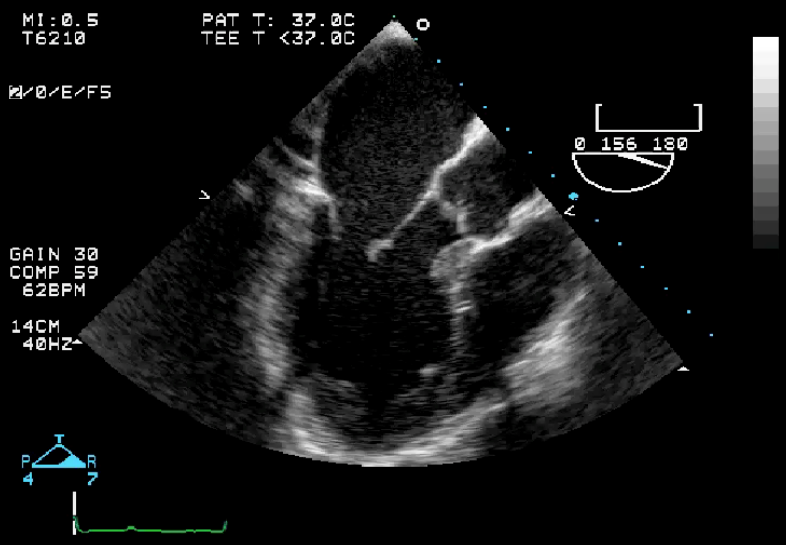


Case #3: Identify the prolapsing scallop

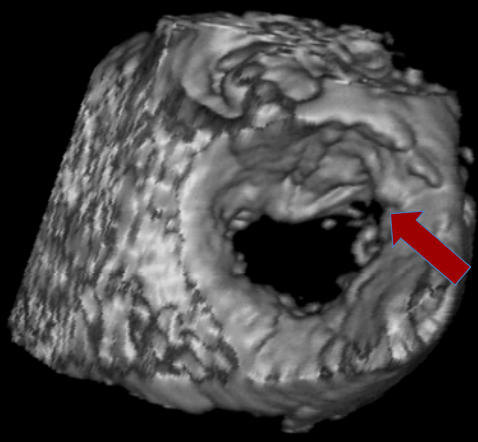


60^0

Case# 3: Identify the prolapsing scallop

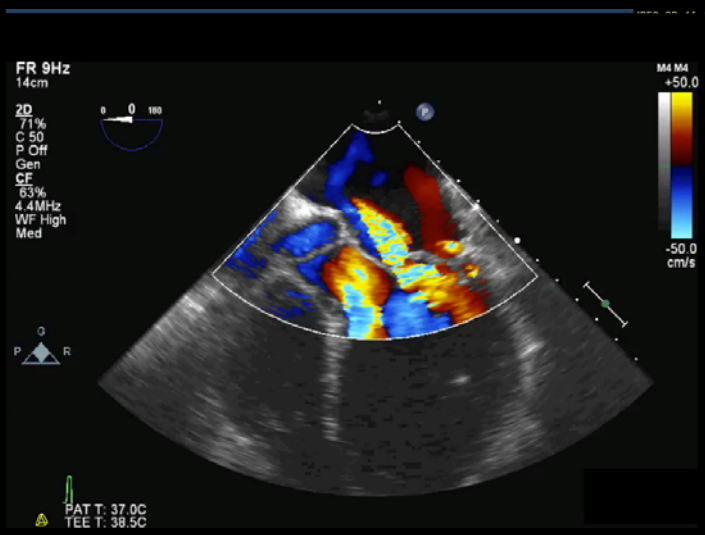


Case# 3: Identify the prolapsing scallop



Case# 4: Identify the prolapsing scallop

Case# 4: Identify the prolapsing scallop



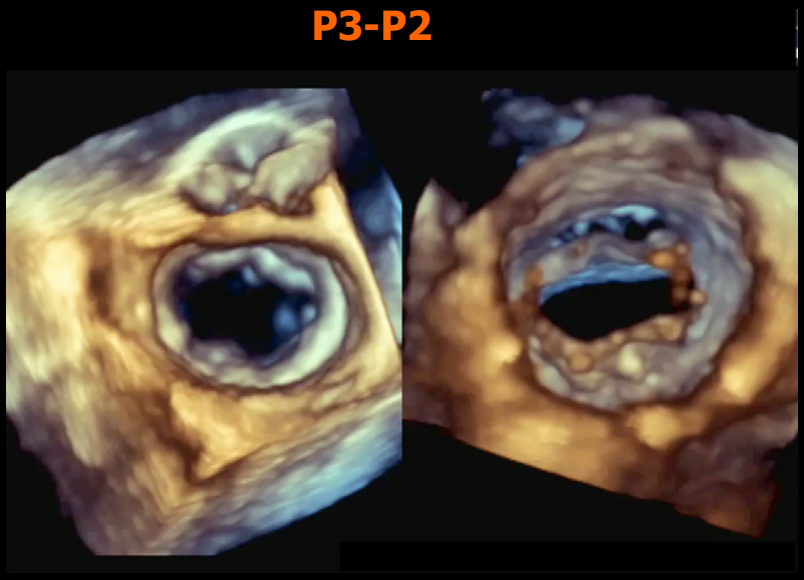
0^0

Case# 4: Identify the prolapsing scallop

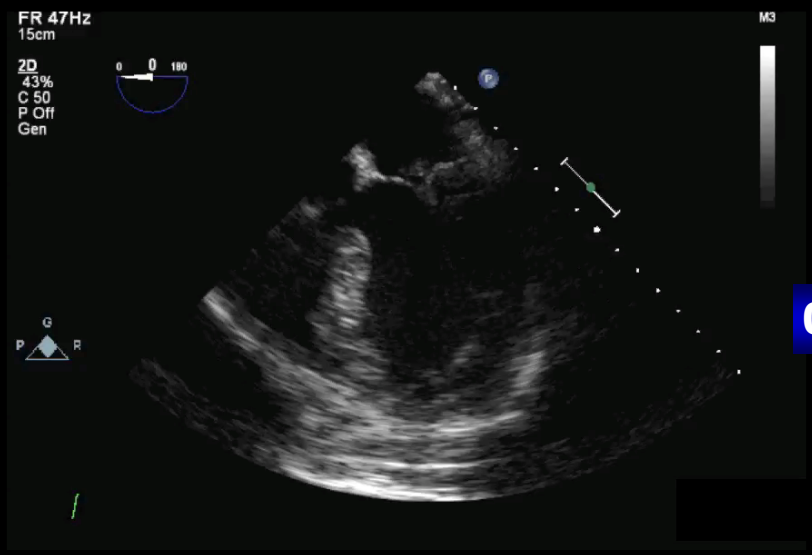
80^0

Case# 4: Identify the prolapsing scallop

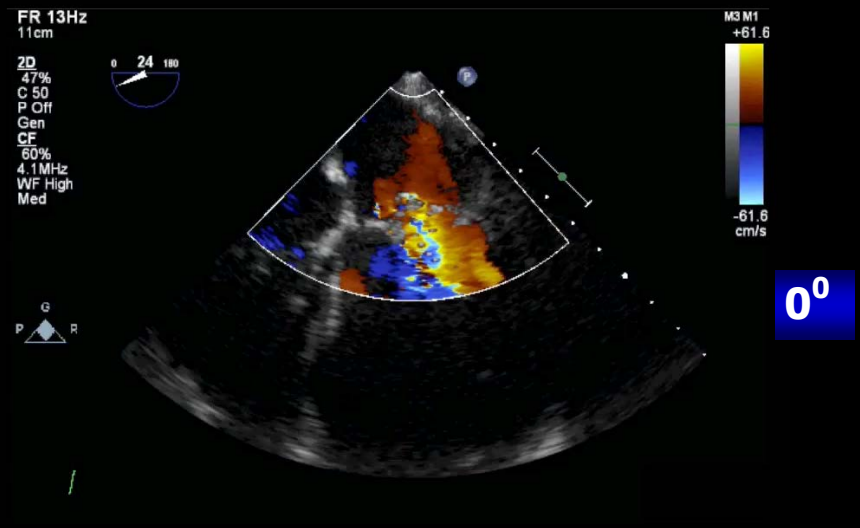
P3-P2



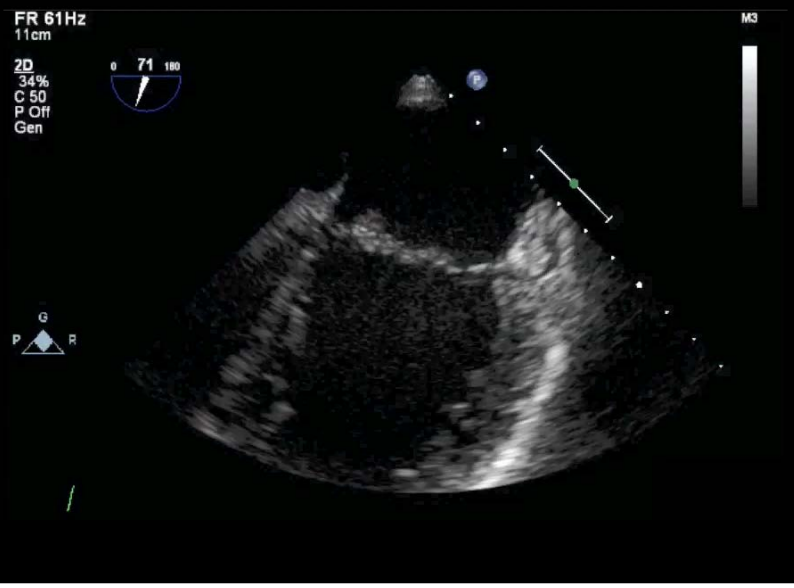
Case# 5: Identify the prolapsing scallop



Case# 5: Identify the prolapsing scallop



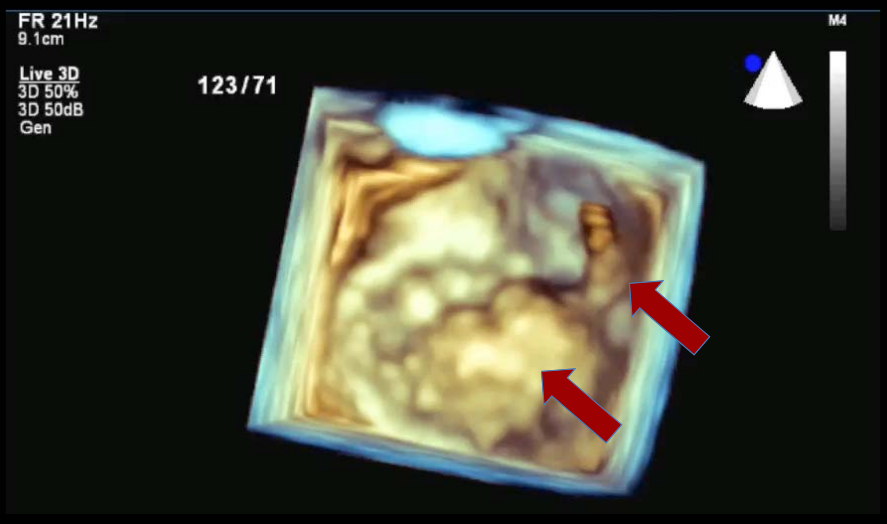
Case# 5: Identify the prolapsing scallop

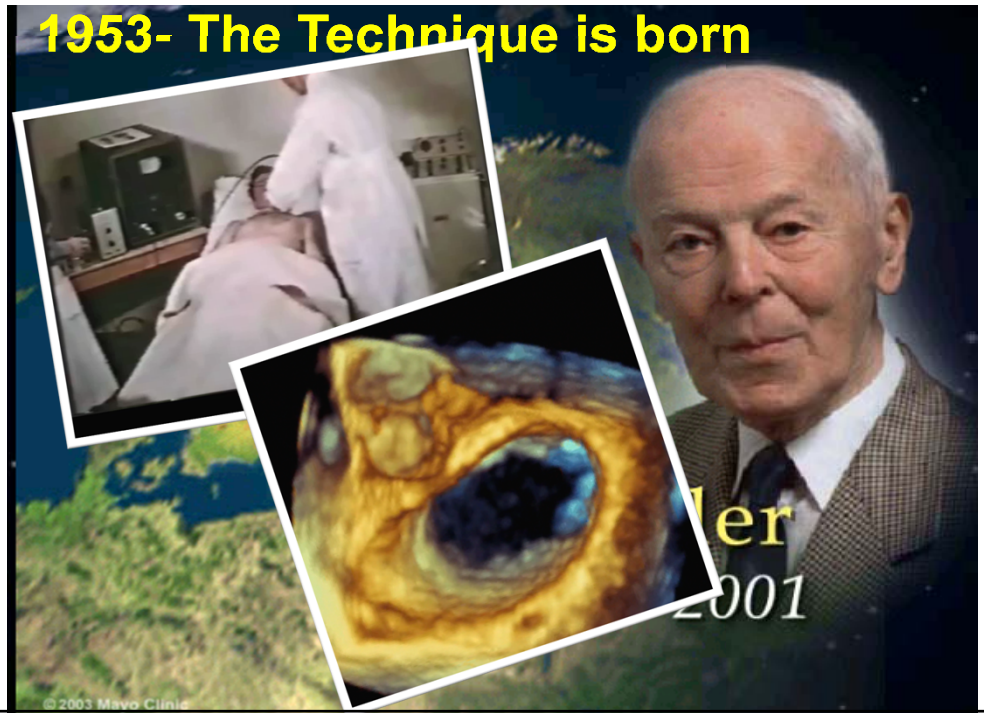


Case# 5: Identify the prolapsing scallop

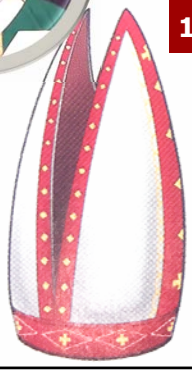
Case# 5: Identify the prolapsing scallop

P3 flail, P2 prolapse



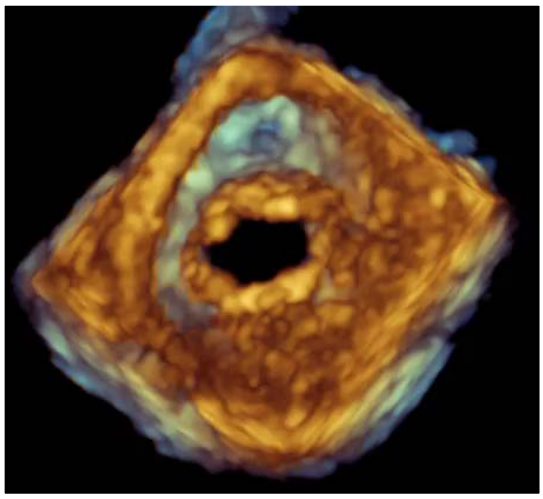


The Mitre typically worn by popes and cardinals is depicted along side a cross-sectional image of the MV. Andreas Vesalius, father of anatomy, noted the striking similarities betweenthe two.



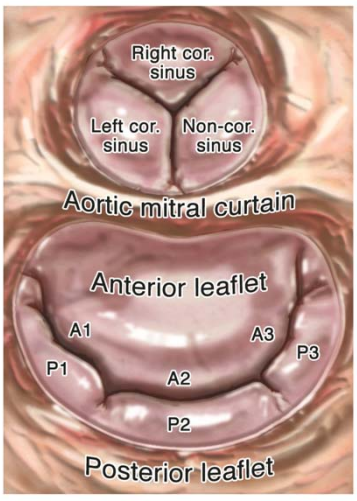
Andreas Vesalius
De Humani Corporis Fabrica
1543

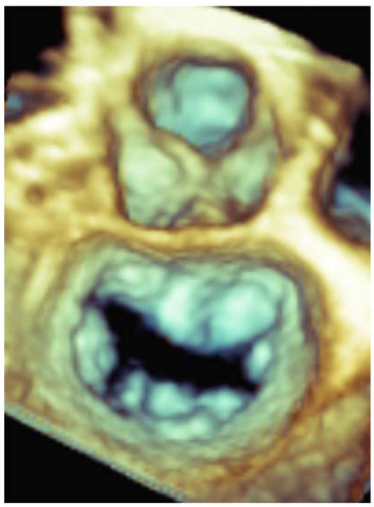
Matrix TEE Probe: 2007



Sugeng L, Shernan SK, Salgo IS, Weinert L, Shook D, Raman J, Jeevanandam V, DuPont F, Settlemier S, Savord B, Fox J, Mor-Avi V, Lang RM. *J Am Coll Cardiol* 2008 August 5;52(6):446-449.

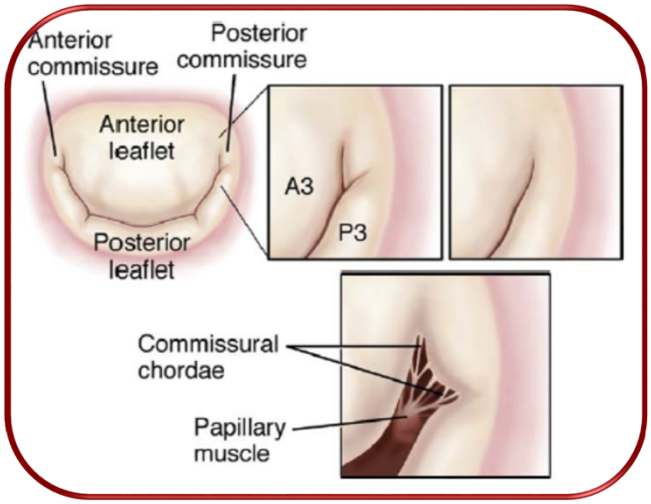
Surgeon's View of the MV





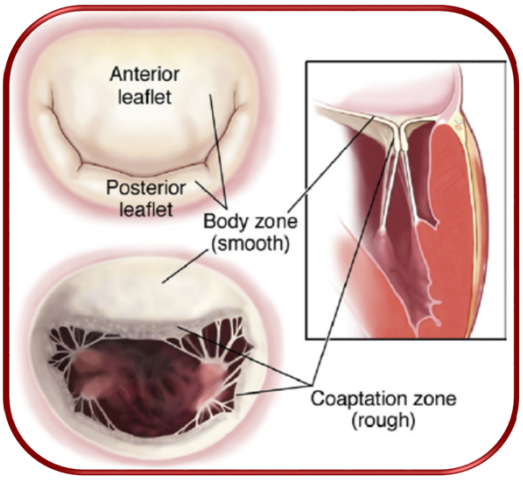
Lang RM, Tsang W, Weinert L, Mor-Avi V, Chandra S. J Am Coll Cardiol 2011 November 1;5 8(19):1933-1944.

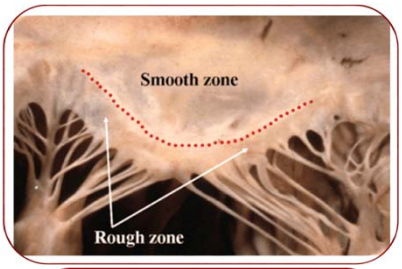
Commissures

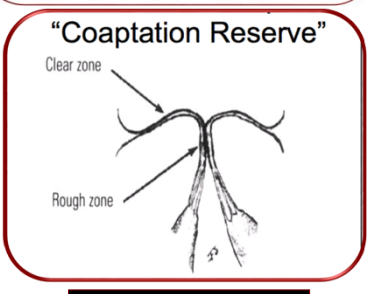


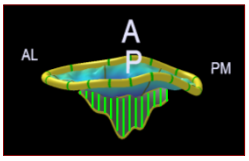
Journal of Cardiothoracic and Vascular Anaesthesia, Vol 23, No 4 (August), 2009: pp 531-543

Coaptation Zone



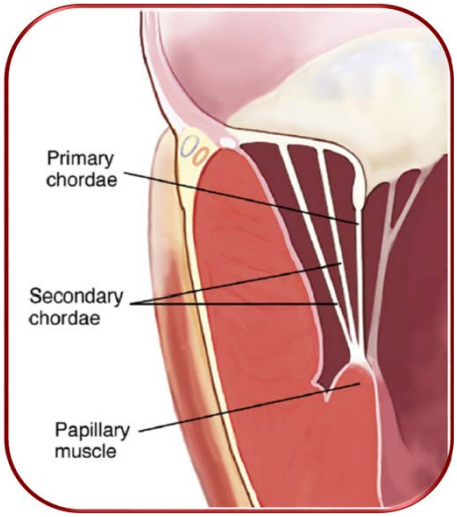


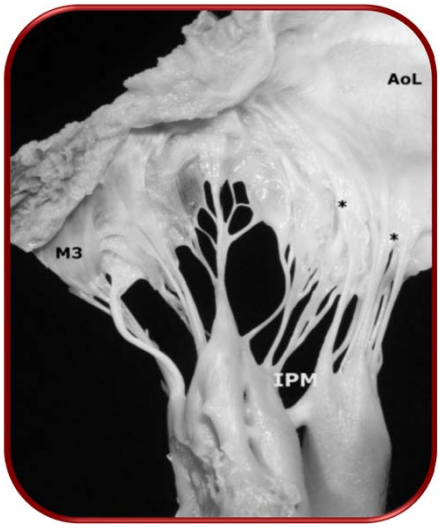




Journal of Cardiothoracic and Vascular Anaesthesia, Vol 23, No 4 (August), 2009: pp 531-543

Primary, Secondary and Tertiary Chordae

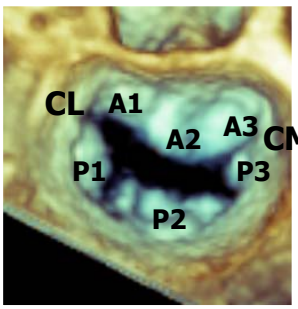




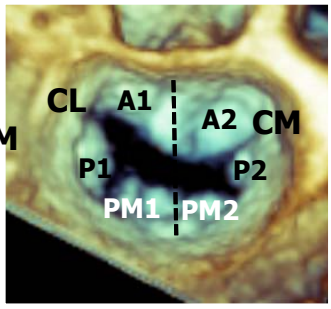
Journal of Cardiothoracic and Vascular Anesthesia, Vol 23, No 4 (August), 2009: pp 531-543

Clinical Anatomy 22:85-98 (2009)

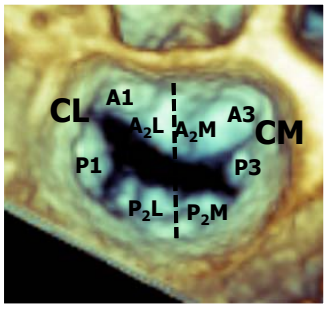
Classification Schemes



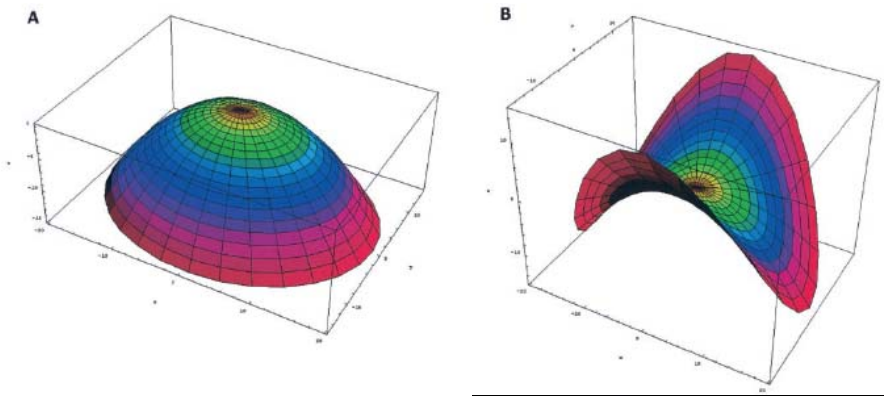
Carpentier



modified Duran

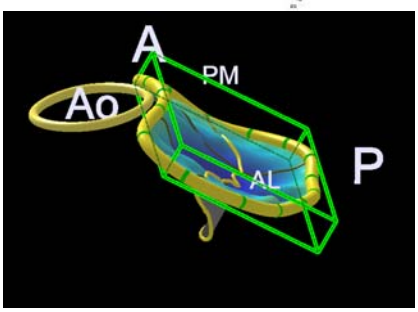


modified Carpentier

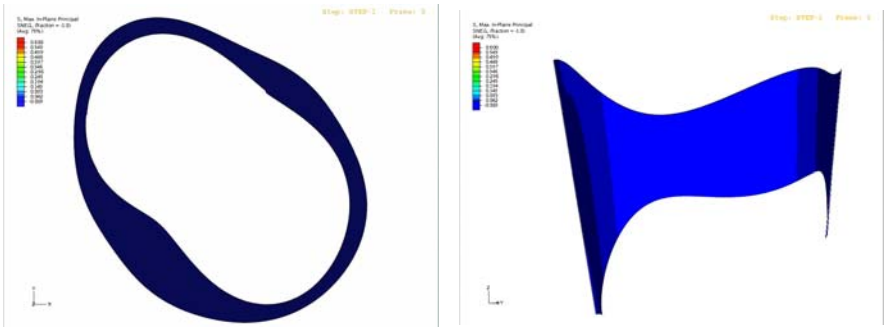


Effect of Annular Shape on Leaflet Curvature in Reducing Mitral Leaflet Stress

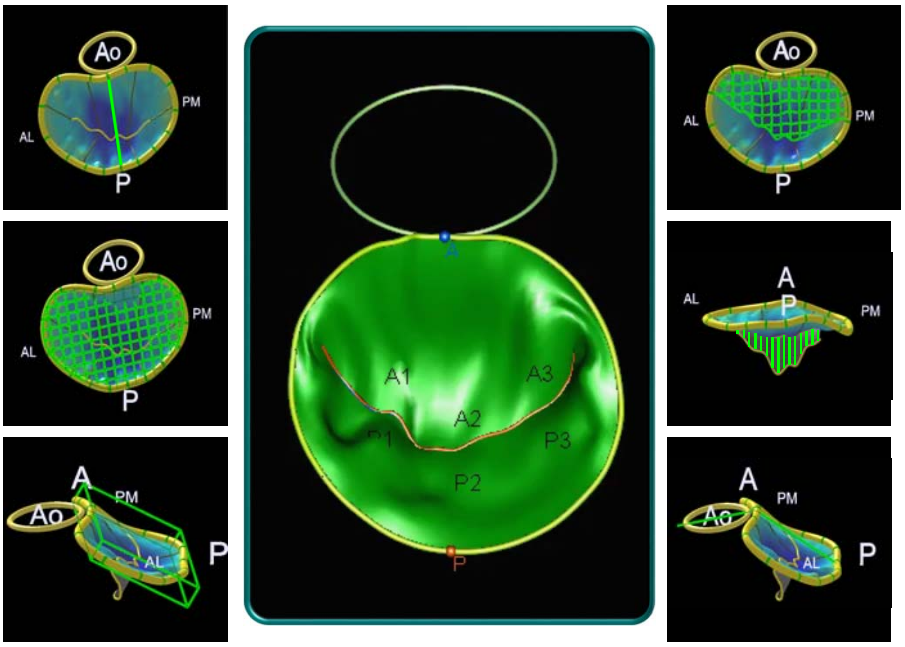
Salgo I et al Circulation 2002; 106:711-717



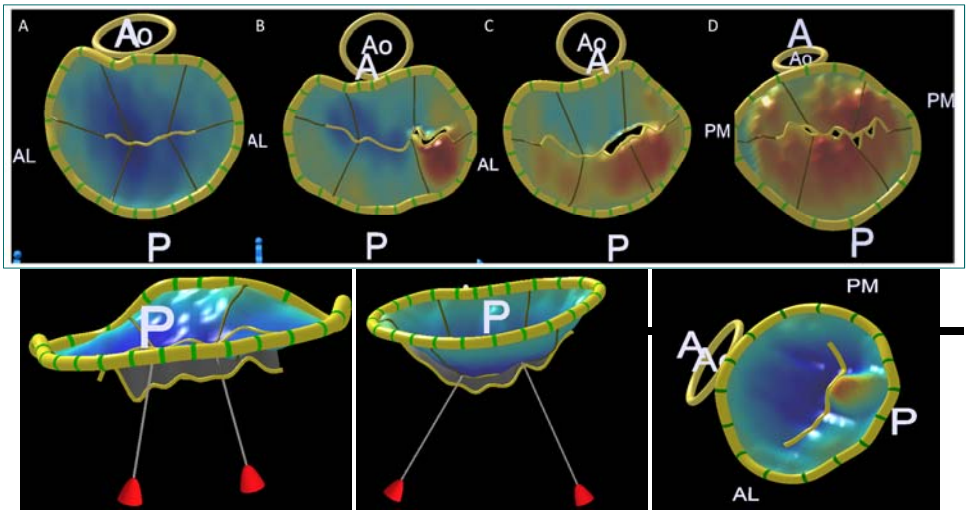
MV Leaflet Stress



[Caiani and Votta, www.surgaid.org]

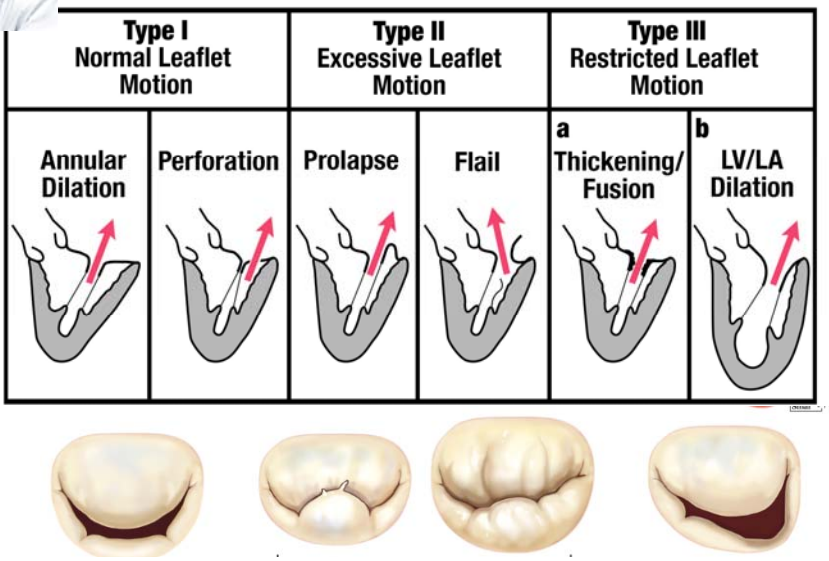


MV Parametric Maps

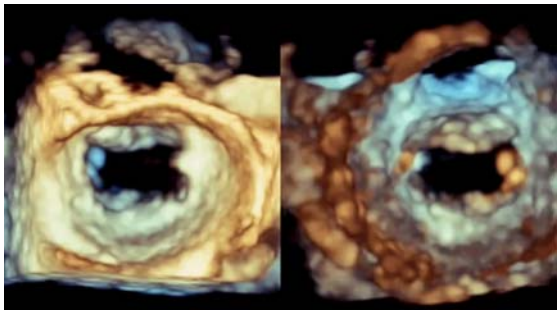


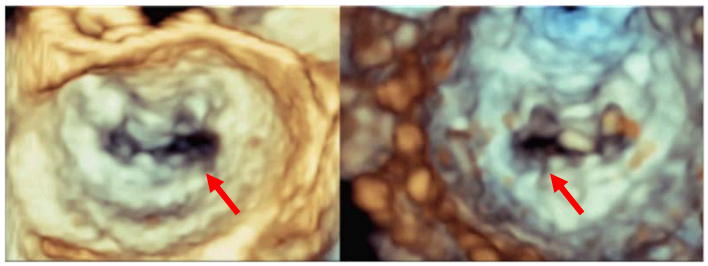
Tsang W, Lang RM., *J Am Soc Echocardiogr* 2011;24:860-7.

Carpentier's Functional Classification

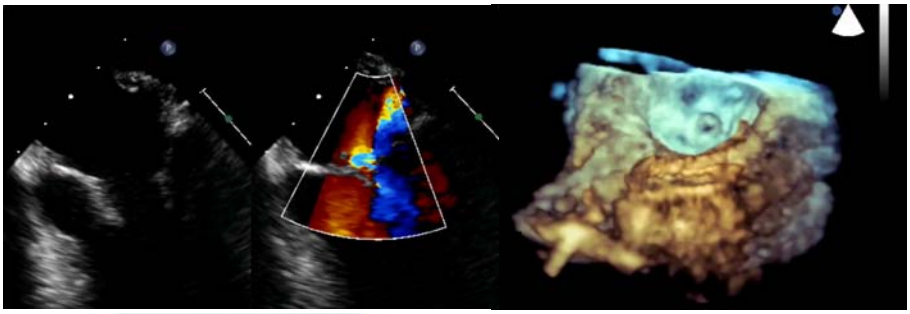


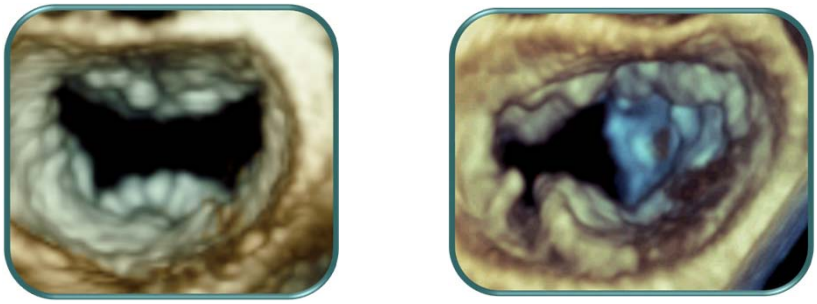
Type I: Normal Leaflet Motion





Type I: Normal Leaflet Motion

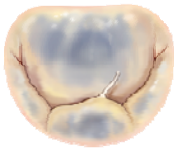


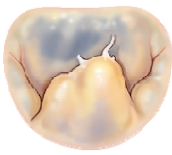


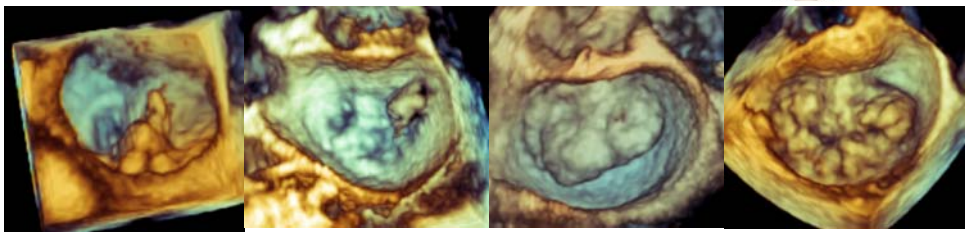
Type II: Degenerative MV Disease

Excess Tissue

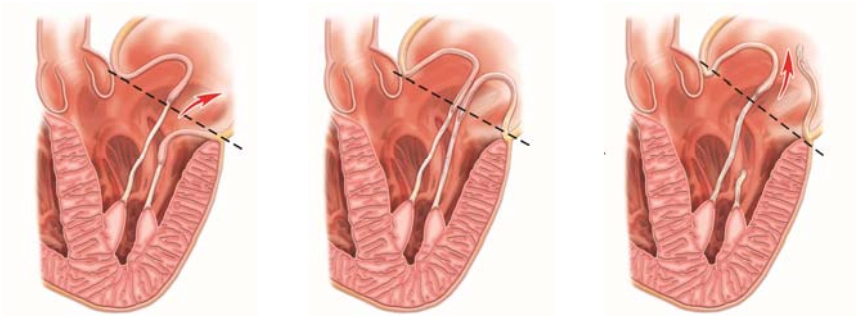
+	++	+++	++++
FED	FED+	Form Fruste	Barlow's







Degenerative MV Disease

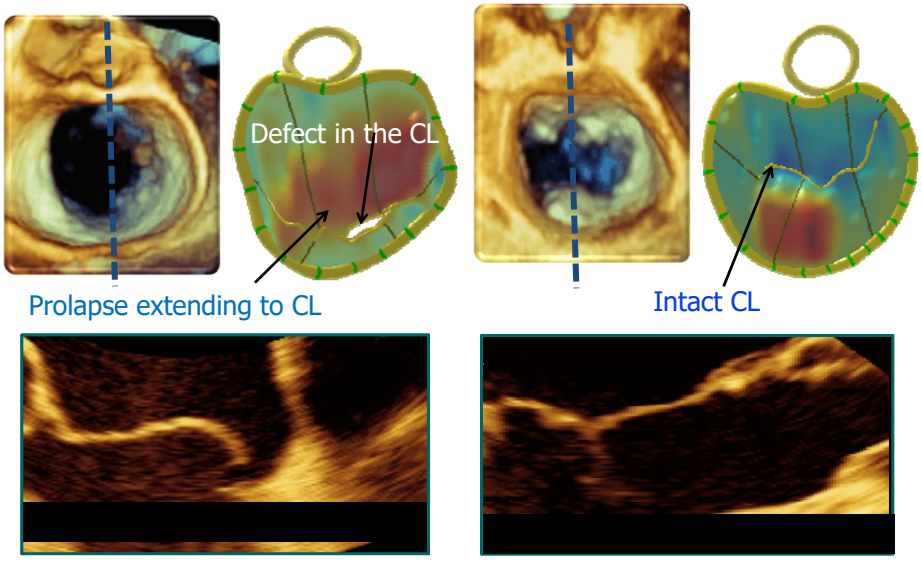


Prolapse: **Free edge of the leaflet above the plane of the annulus at end-systole. Disruption of coaptation.**

Billowing: **Systolic protrusion of leaflet body above the annulus plane Free leaflet edge remaining at or below the annular plane during end-systole**

Lang RM, Tsang W, Weinert L, Mor-Avi V, Chandra S. J Am Coll Cardiol 2011 November 1;5 8(19):1933-1944.

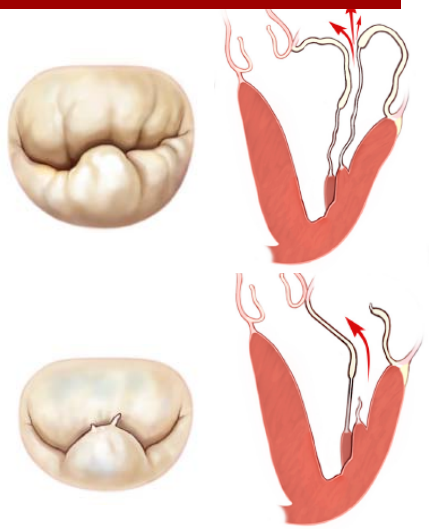
3D Definition for Billowing and Prolapse



Addetia K , Lang RM et. al. J Am Soc Echocardiogr. 2014 Jan;27(1):8-16

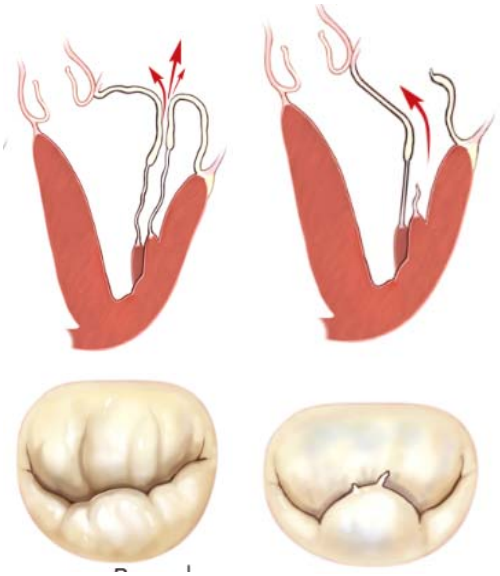
Type II: Fibroelastic Deficiency

- **Etiology (cause):** fibroelastic deficiency
- **Lesions (result of the disease):** chordal elongation and/or rupture, annular dilatation
- **Leaflet dysfunction (which result from the lesions):** Type II = excess motion of the margins of the leaflets in relation to the annular plane



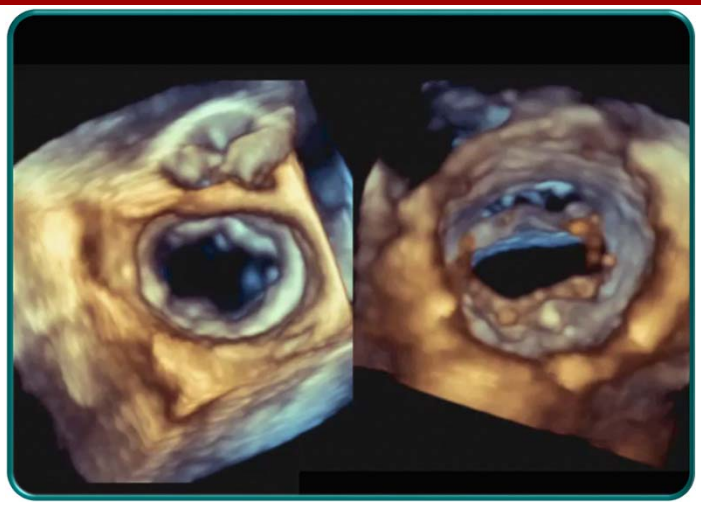
- **Older individuals**
- **Short Hx of MR**

Type II: Fibroelastic Deficiency



- **Older individuals**
- **Short Hx of MR**
- **Rupture or elongation of a single chord**
- **Remaining segments are normal**
- **Posterior annulus may be dilated**

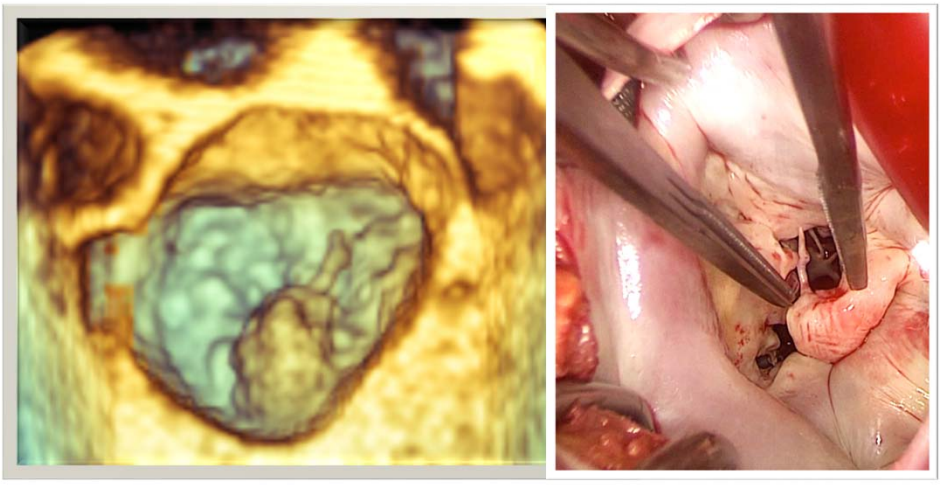
Type II: Fibroelastic Deficiency



P2 - Prolapse

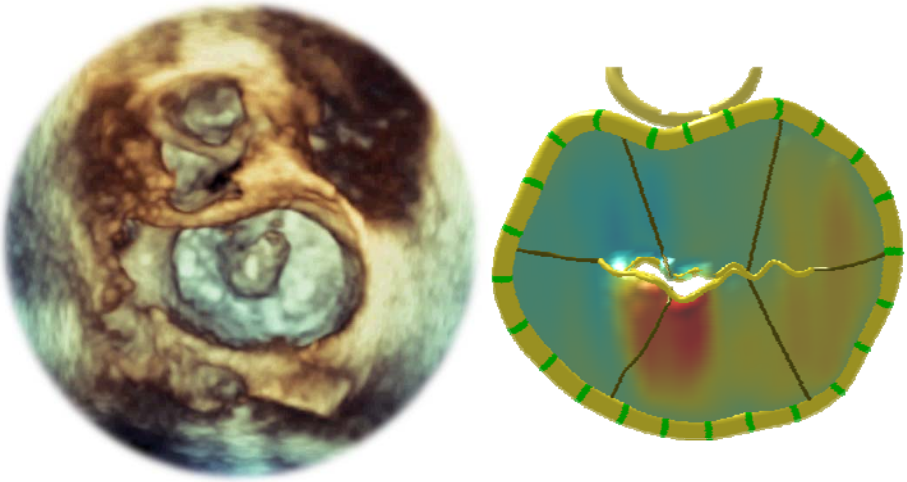
Fibroelastic Deficiency

Flail MV: Ruptured chords

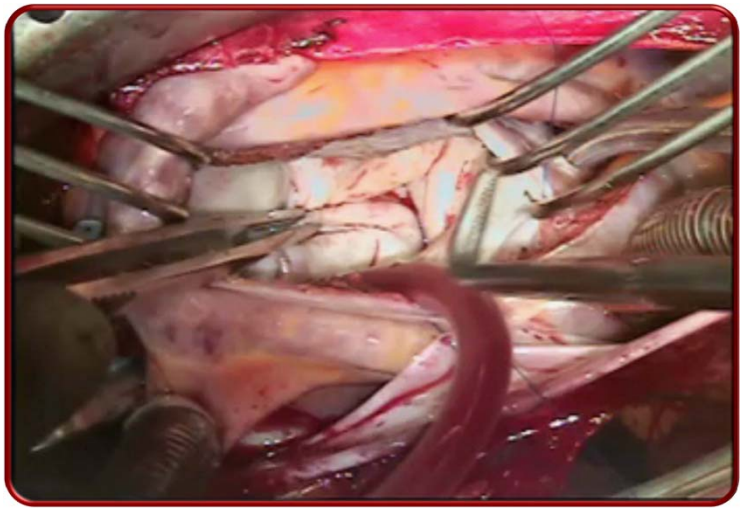


Chandra S,. *Circ Cardiovasc Imaging* 2011 January; 4(1):24-32.

Type II: Fibroelastic Deficiency



Type II: Fibroelastic Deficiency

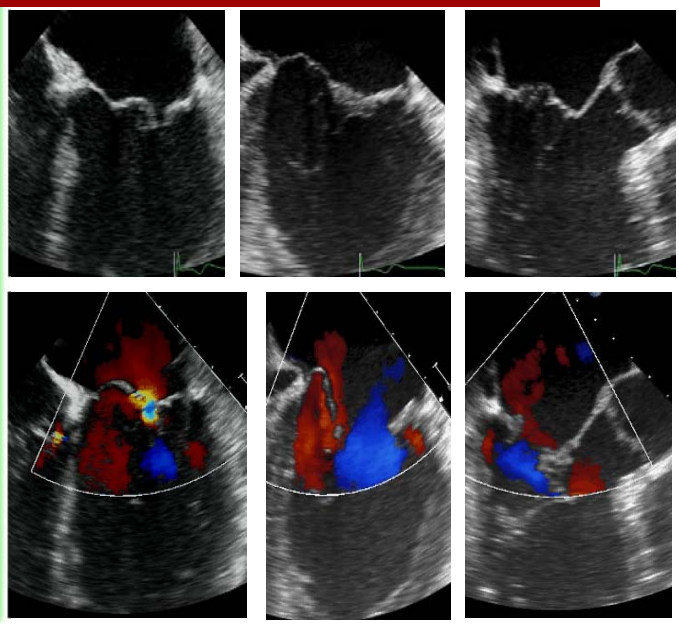


Flail MV: Ruptured chords

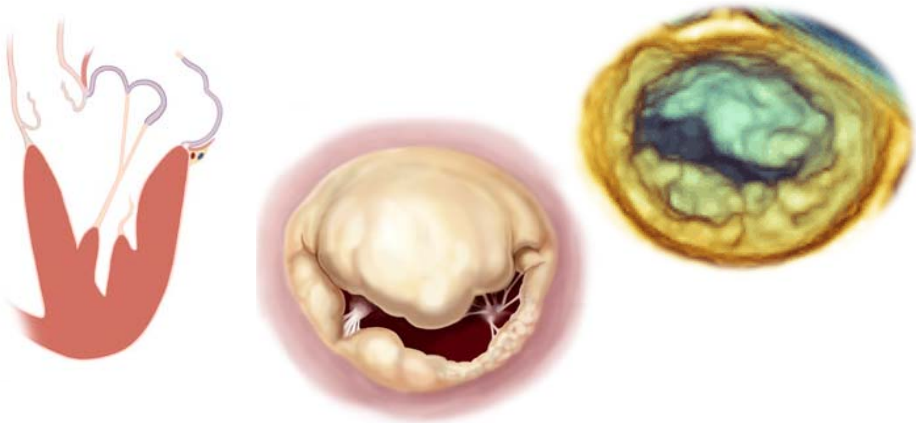
Type II: Barlow's Prolapse

Case History

42year-old woman who complains of decreased exercise capacity of recent duration.

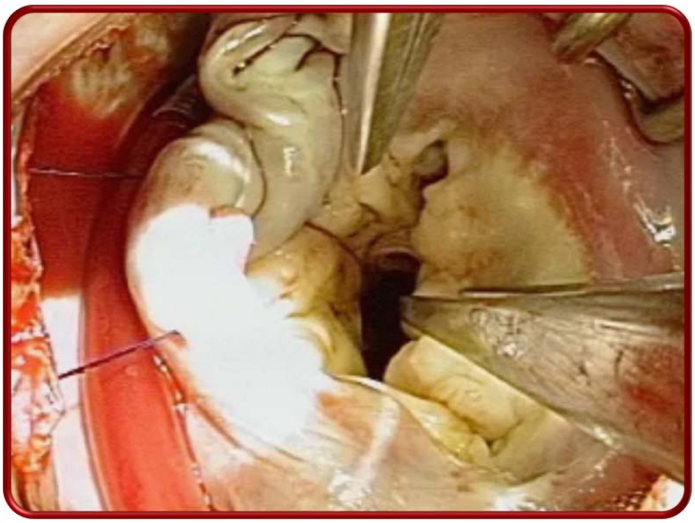


Type II: Barlow's Prolapse



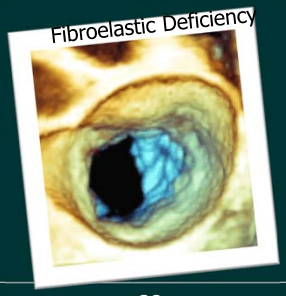
Excess leaflet tissue with billowing, thickened leaflets and chordae, large annulus

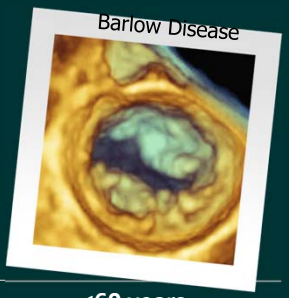
Barlow's Prolapse



Fibroelastic Deficiency vs. Barlow Disease

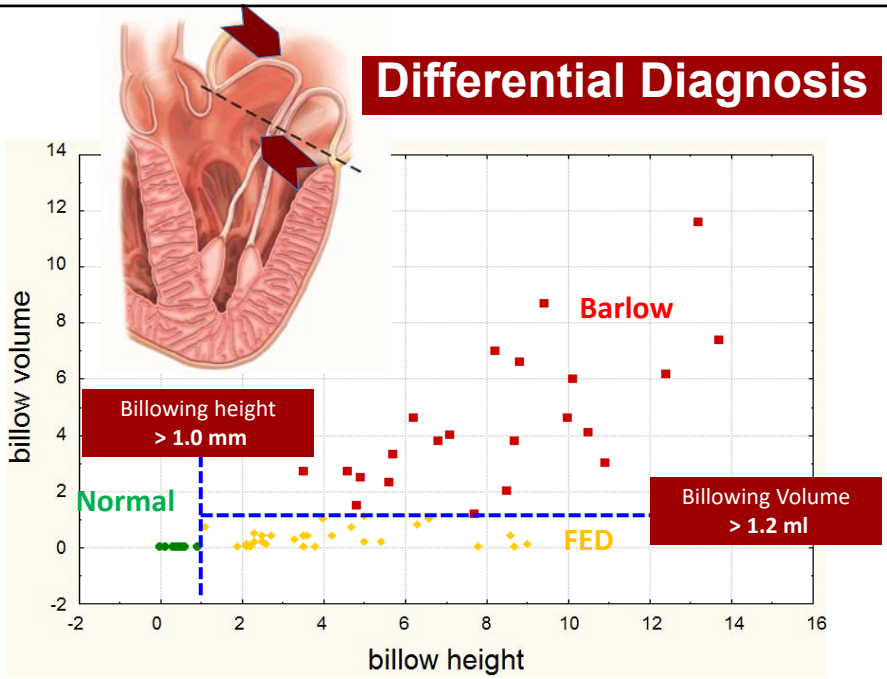
Carpentier et.al. J Thorac Cardiovasc Surg 1980





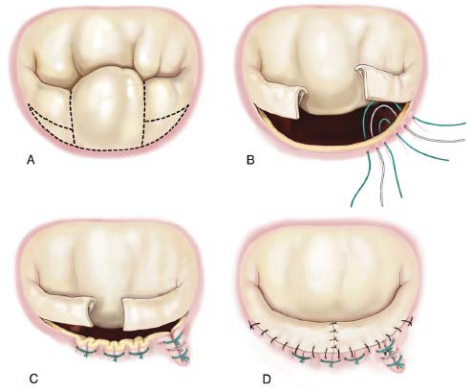
Age at diagnosis	>60 years	<60 years
History of MR	<5 years	>10 years
Annular Dilatation	<32 mm	>36 mm
Leaflet Tissue	Thin and transparent without excess tissue	Thickened with diffuse excess tissue
Segmental Distribution	Usually single segment	Multisegmental
Chordae	Thin and ruptured	Irregular and elongated

Differential Diagnosis

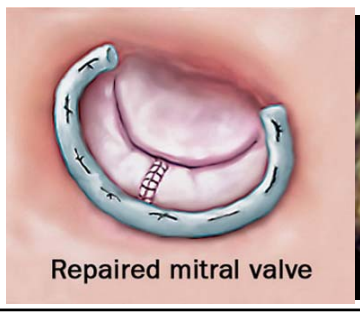


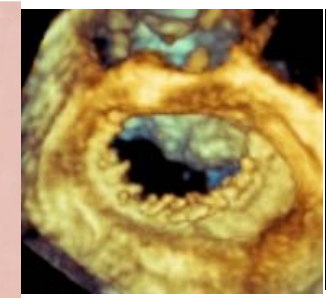
Chandra S, Lang RM et al., *Circ Imaging* 2011: 4(1):24-32

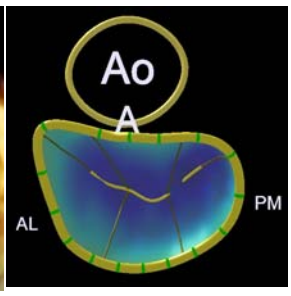
Carpentier Correction

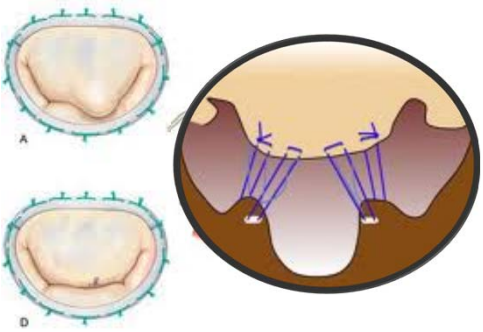


- **Leaflet resection (*reduction in MV area*)**
- **Rigid or semi-rigid annuloplast ring (*distortion of the subvalvular chordae*)**



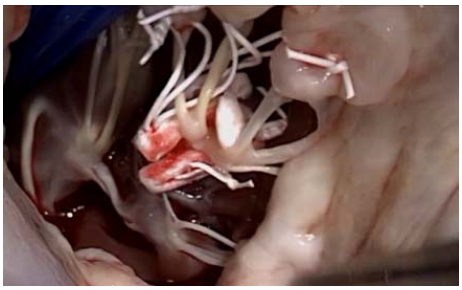


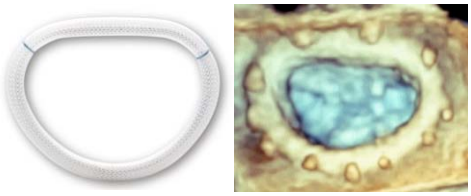




American Correction

- Mitral Valve not resected
- Full flexible ring
- Artificial chordae



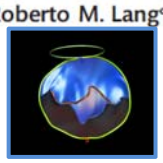


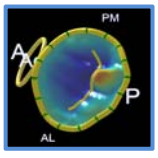
Can three-dimensional echocardiography accurately predict complexity of mitral valve repair?

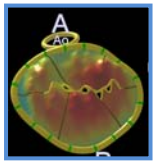
Joanna Chikwe[a,*], David H. Adams[a], Kevin N. Su[b], Anelechi C. Anyanwu[a], Hung-Mo Lin[c], Andrew B. Goldstone[b], Roberto M. Lang[d] and Gregory W. Fischer[b]

Standard Repair
No or single leaflet resection
Sliding-plasty
Cleft Closure
Chordal or commissural repair techniques

Complex Repairs
Bi-leaflet repair techniques
Multiple resections required
Patch augmentation





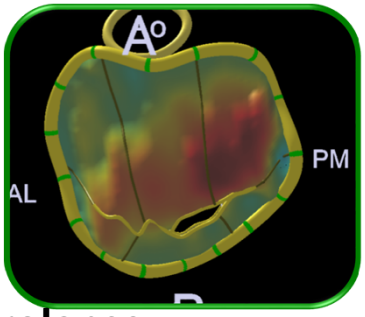


Prediction of Complexity of MV Repair
Multisegment Involvement
Anterior Leaflet Prolapse
Scarcity of leaflet tissue
Severe Calcification
Prolapsing Height
Annular Dilatation > 50 mm

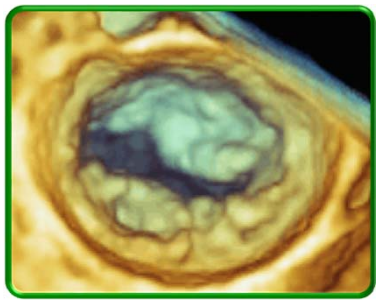
European Journal of Cardio-Thoracic Surgery 2012;41:518-524

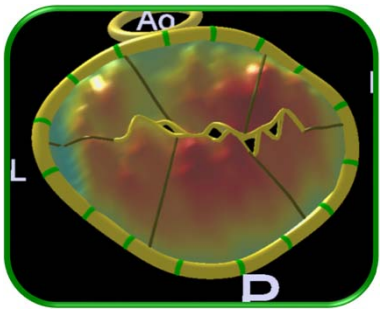
Lang RM et al. J Am Coll Cardiol 2011

Anterior Leaflet Prolapse

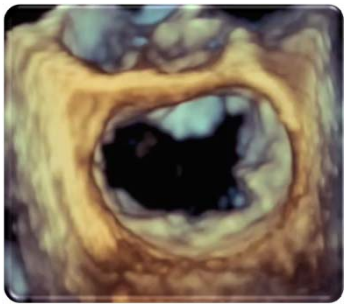


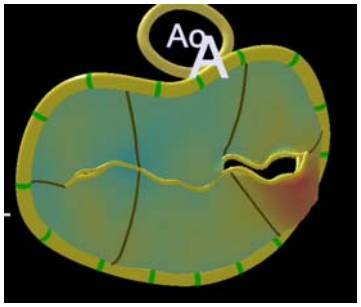
Barlows Prolapse



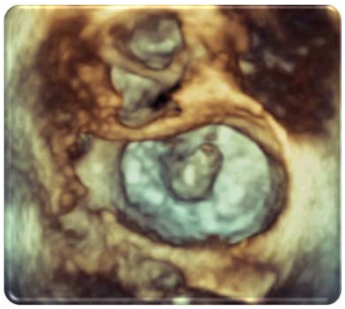


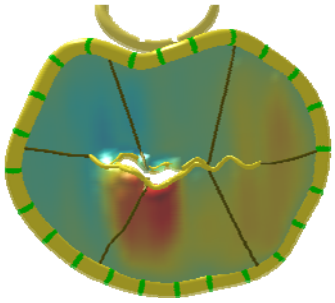
Medial Commissure





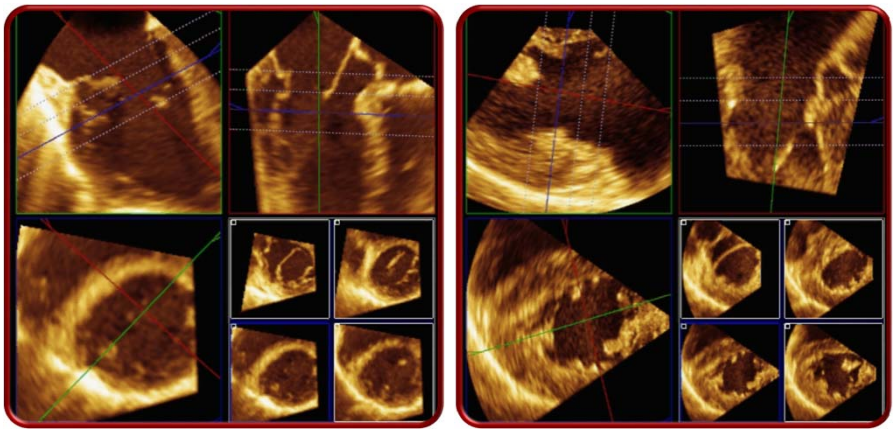
P2 Flail





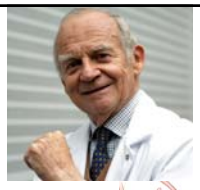
Sub-Mitral Apparatus

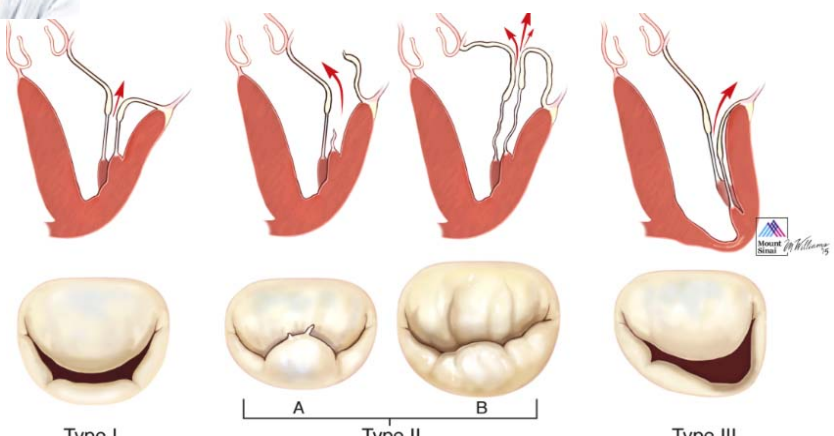
Mid-esophageal | **Transgastric**



Obase and Lang RM, J AM Soc Echocardiogr 2015;28:1302-8

Carpentier's Functional Classification





Type I	Type II	Type III	
Normal Leaflet motion	Excess Leaflet motion	Restricted Opening IIIa	Restricted Closure IIIb

Secondary Mitral Regurgitation

- **MR that is seen in the absence of intrinsic structural abnormalities of the MV leaflets and sub-valvular apparatus.**
- **Usually secondary to adverse remodeling in patients with systolic LV dysfunction caused by ischemic or non-ischemic cardiomyopathy**

Carpentier's Classification System of MR Mechanisms

Type I (Nl Leaflet motion)

Annulus dilatation

Leaflet perforation

Commissure fusion

Leaflet thickening

Chordae fusion

Type IIIa (Systolic leaflet restriction)

Type II (Increased leaflet motion)

Ruptured chordae

Elongated chordae and/or papillary muscle

Rupture PM

Ventricular dilatation

Ventricular dyskinesia

Type IIIb (Diastolic leaflet restriction)

Carpentier A. Cardiac valve surgery -J Thorac Cardiovasc Surg 1983;86:323-337

Secondary Mitral Regurgitation

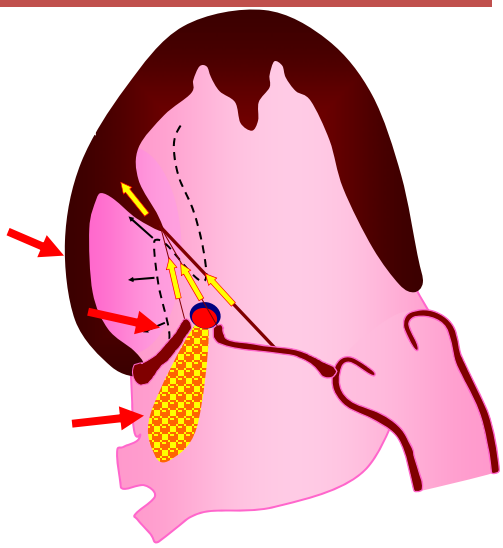
- CAD, related MI
  - (ischemic chronic secondary MR)
- Idiopathic myocardial disease
  - (non-ischemic chronic secondary MR)

Secondary Mitral Regurgitation

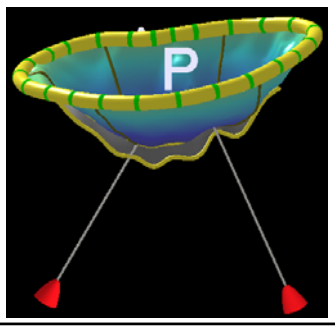
- Occurs in roughly 25% of patients following MI and 50% of those with CHF.
- Any degree of ischemic MR conveys an adverse prognosis
- Propensity of recurrence of MR following ring annuloplasty

Secondary Mitral Regurgitation

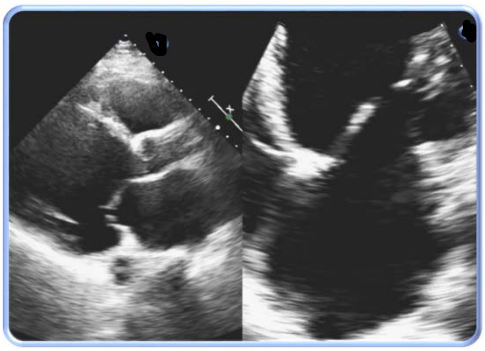
- **Inferior MI**
- **Local LV RWMA**
- **LV dilatation**
- **P-Medial PM displacement**
- **Leaflet Restriction**
- **Posterior Jet (P3)**

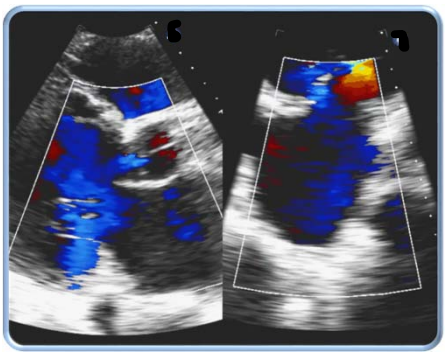


Courtesy Alain Berrebi

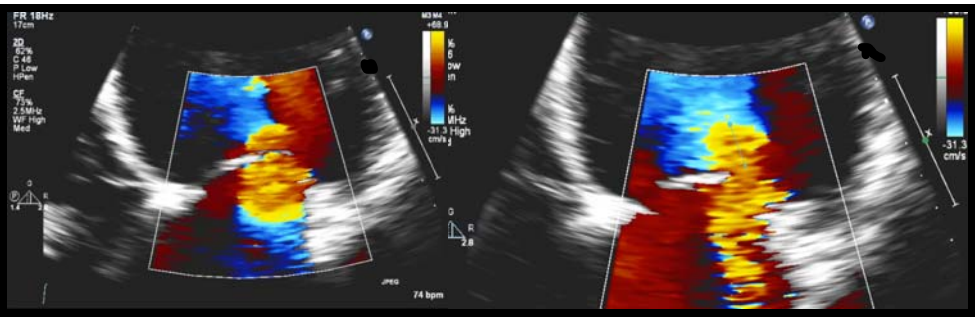


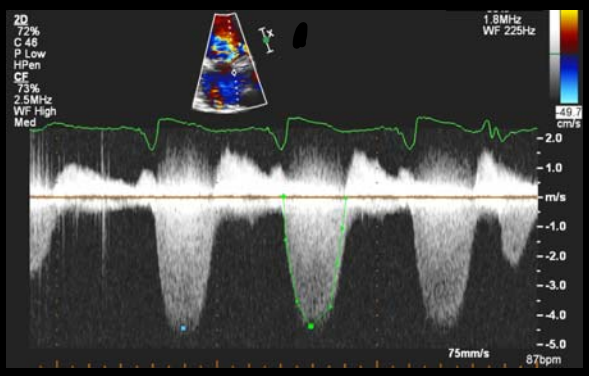
Functional MR





- 72 yo AAF with h/o HTN and CAD s/p IMI and RCA stent presents with SOB.
- Progressive DOE since her MI

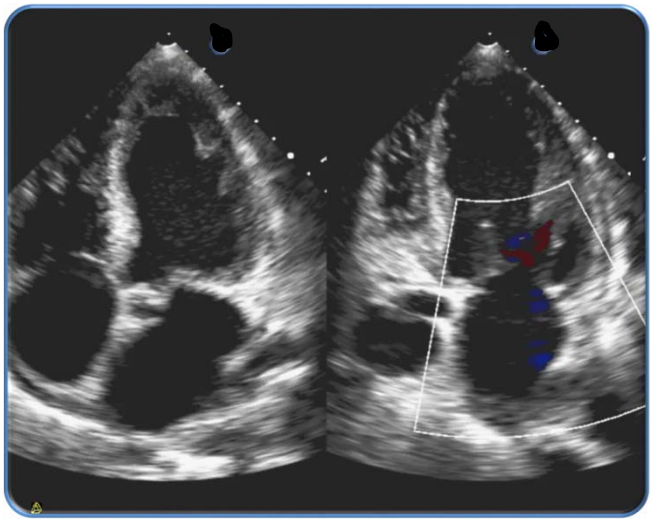




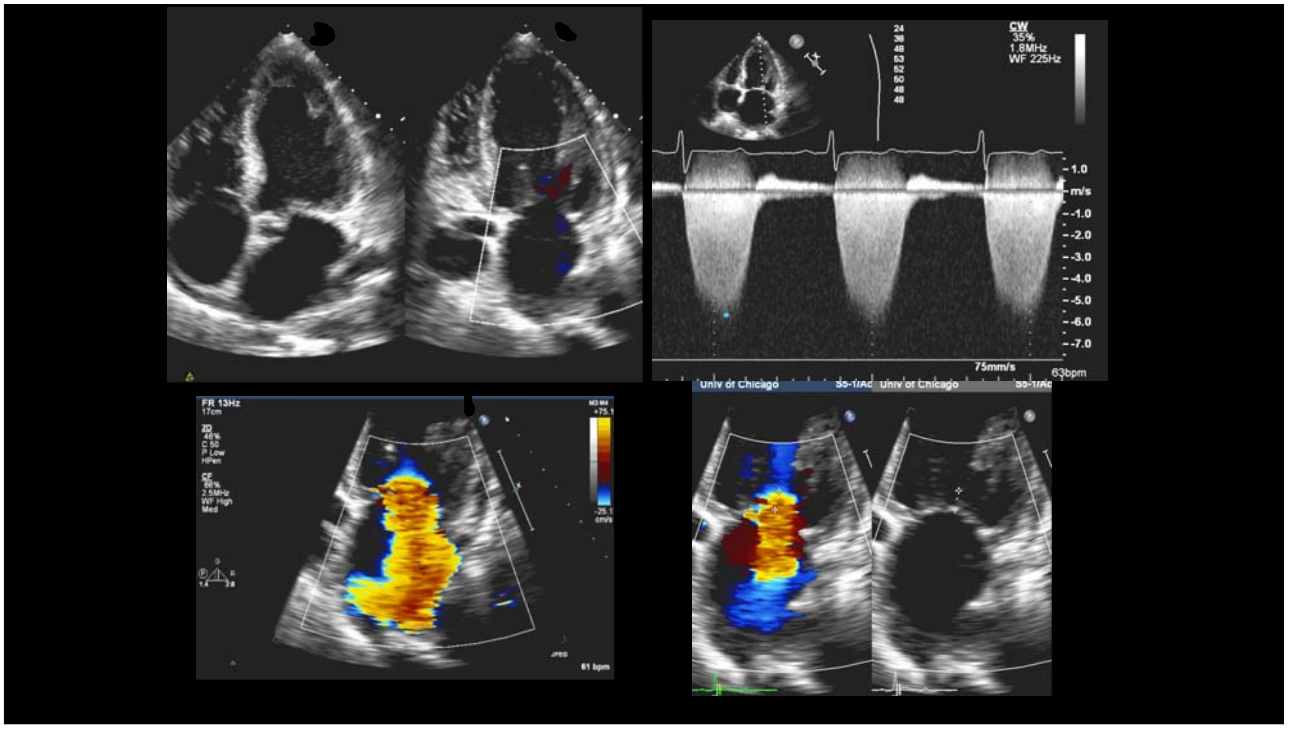
ERO = 0.48 cm^2

RV = 48 ml

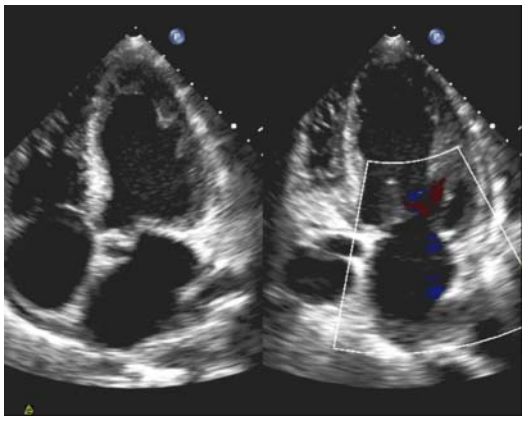
62 year old with IDCM and shortness of breath despite optimal treatment

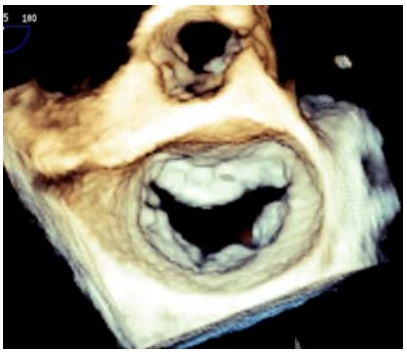


(non-ischemic chronic secondary MR)



Functional MR

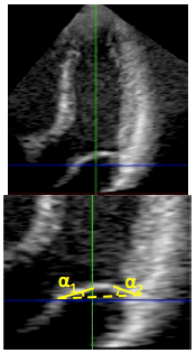




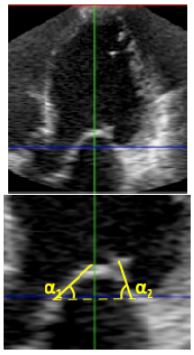
(non-ischemic chronic secondary MR)

Asymmetric Tethering

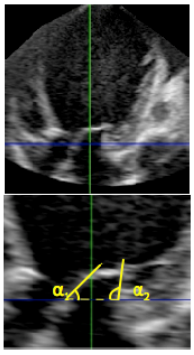
normal

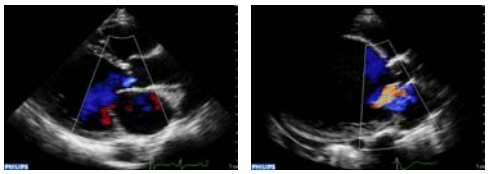


moderate

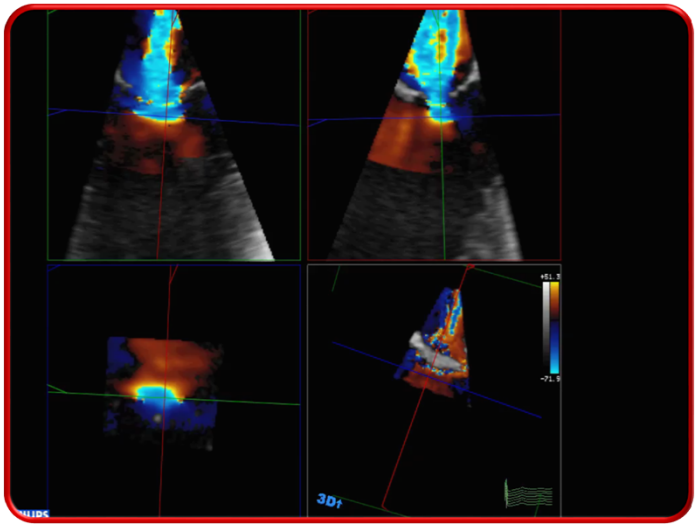


severe



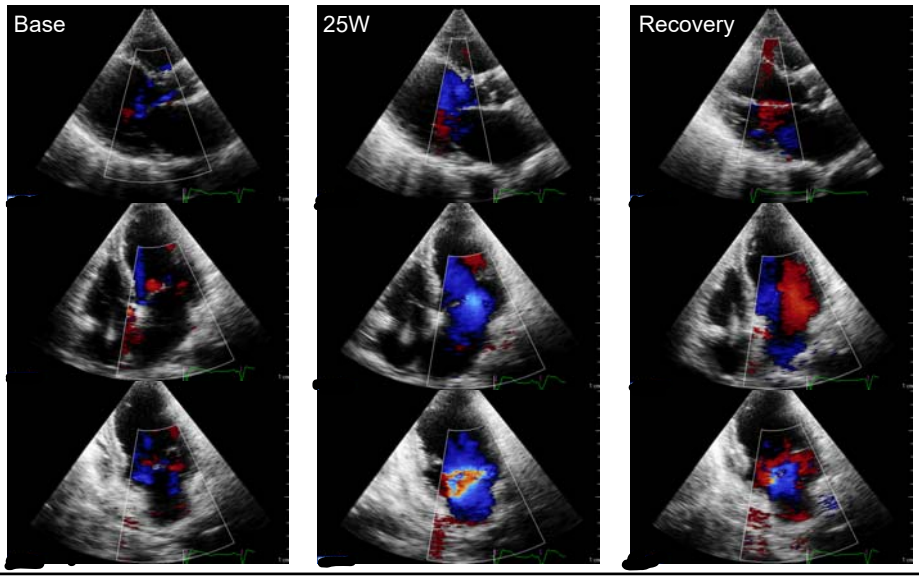


Ischemic MR: ERO



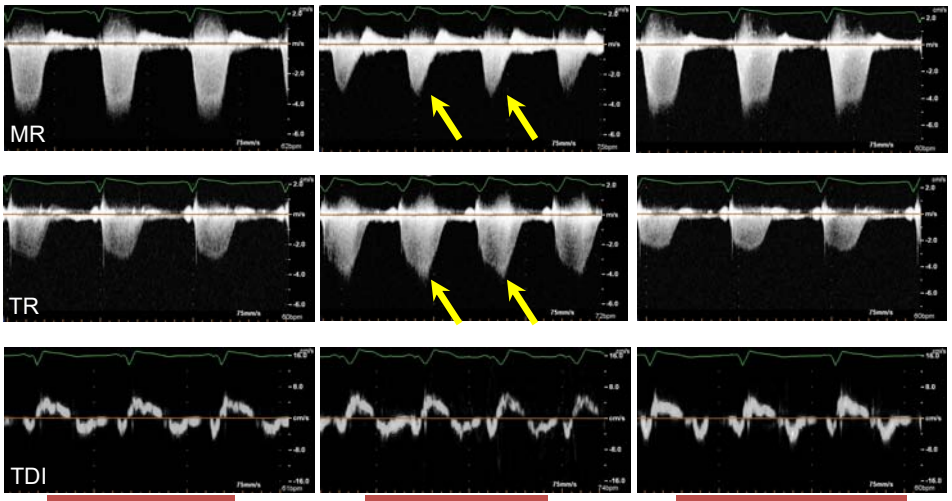
Ischemic MR

Dynamic changes in the degree of MR with exercise in a patient with AWMI



Ischemic MR

Dynamic changes in the degree of MR with exercise in a patient with AWMI



Base (BP: 106/67) | 25W (BP: 106/61) | Recovery (BP: 116/68)

Secondary MR: Facts

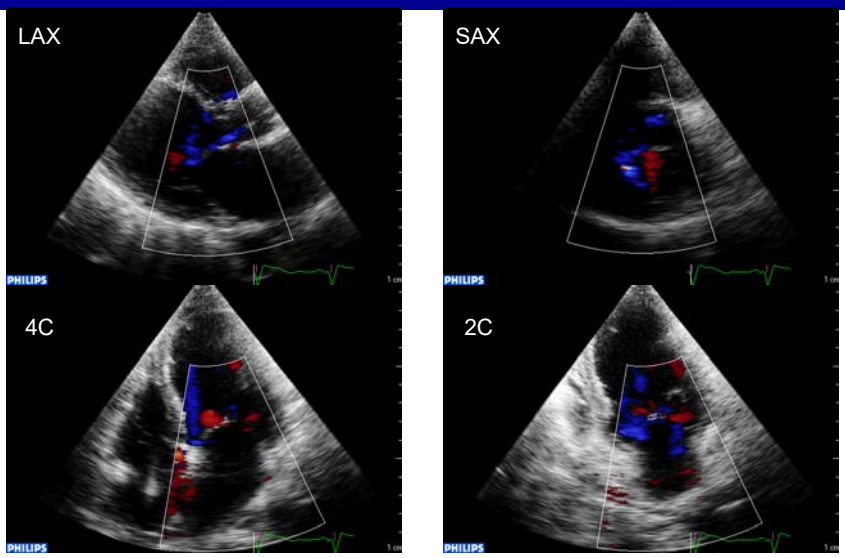
- Greater difficulty in defining the severity of MR
- Adverse outcomes are associated with a smaller calculated ERO
  - Associated progress of LV systolic dysfunction.
  - Underestimation of ERO area by 2D y due to the crescentic shape of the RO.

Conclusions

- Restricted leaflet motion, increased leaflet tethering caused by papillary muscle displacement and LV dilatation are the main determinants of IMR.
- Dynamic nature of IMR can often cause underestimation. Exercise may provide a better evaluation of severity and prognosis
- Greater difficulty in defining the severity of MR Underestimation of severity due to the crescentic shape of the ERO.
- Adverse outcomes are associated with a smaller calculated ERO. Associated progress of LV systolic dysfunction.

Ischemic MR

Dynamic changes in the degree of MR with exercise in a patient with AWMI



Secondary MR: Surgery

Because MR is only one component of the disease (severe LV dysfunction, CAD, or idiopathic myocardial disease) restoration of mitral competence is not curative

Surgical options are not clear

Thanks for your attention

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